GROWTH AND DEVELOPMENT * PHYSIQUE

20

Symposia Biologica Hungarica

20

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PHYSIQUE

Akadémiai Kiadó, Budapest

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Symposia Biologica Hungarica 20

Edited by
O. G. EIBEN

The Symposium, organized in Balatonfüred by the Department of Anthropology, Eötvös Loránd University, Budapest dealt with the problems of growth and development, as well as with the variations of physique. The present volume contains the papers of research workers from eighteen countries from all over the world. The first section discusses the genetic and environmental factors influencing growth processes. Thus, papers analyze the effect in growth and development and maturity of climatic, socio-economical, nutritional, and other factors, intrauterine growth, and the maturation of girls (age at menarche), as well as the phenomenon of secular trend and the so-called "acceleration" of growth. Some papers give a view about growth studies made in different countries, others deal with the clinical and/or physical educational aspects of these investigations.

The second section of this book presents papers analyzing the variations of physique. Besides the two main methods: somatotyping and factor analysis, there are studies connected with clinical and/or physical educational applications, as well as studies on body composition.

The present volume gives a good summary on modern results concerning these two fields of human biology.

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was held at Balatonfüred between 27th September and 1st October, 1976.

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PREFACE

In connection with the "summing up" phase of the International Biological Programme, the Department of Anthropology, Eötvös Loránd University, Budapest, organized an International Symposium on Human Biology, at Balatonfüred between 27th September and 1st October, 1976. As main subjects of the Symposium, the problems of growth, development and maturity as well as the variations of physique were chosen: themes which had been in the centre of interest long ago. The picturesque, autumnal Balaton-shore offered optimal conditions to the Symposium. The present volume contains the papers of research workers from eighteen countries from all over the world.

In the first section we discussed the genetic and environmental factors influencing growth processes. Thus, papers analyze the effect in growth and development and maturity of climatic, socio-economical, nutritional, and other factors, the intrauterine growth, and the maturation of girls (age at menarche), as well as the phenomenon of secular trend and the so-called "acceleration" of growth. Some papers give a view about growth studies made in different countries, others deal with the clinical and/or physical educational aspects of these investigations.

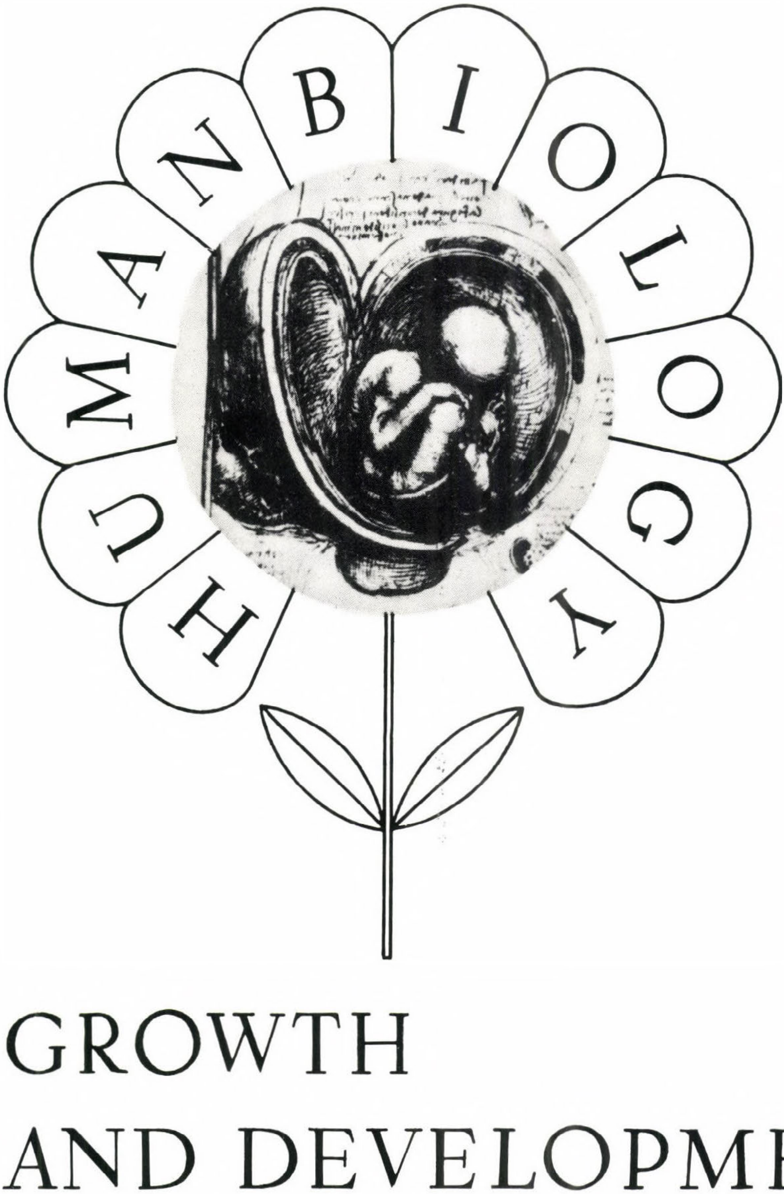
While in the second section the papers analyze the variations of physique. Besides the two main methods: somatotyping and factor analysis, studies connected with clinical and/or physical educational applications, as well as studies on body composition were also touched upon.

It is my firm belief that these topics are timely and interdisciplinary approximation is fruitful and useful for various branches of science, especially as far as universal children health is concerned. With the publication of the present volume we hoped to contribute towards this end. In order to have an early date of issue we requested authors to send their papers in final form. In some cases, however, the standard was not reached, these papers were retyped. Our basic principle was to publish papers in their original form.

At this place, it is my pleasant duty to thank the Biological Section of the Hungarian Academy of Sciences which extended support, both ethical and material, in the realization of the Symposium, making it thereby possible for the Hungarian physical anthropology to open its windows wide at the world.

I would also like to thank the Akadémiai Kiadó and the Akadémiai Nyomda for the smart finish and quick publication of the volume.

O. G. Eiben



GROWTH AND DEVELOPMENT PHYSIQUE

Symposium on Human Biology

Balatonfüred - Tihany 1976

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Growth and Development; Physique *Symp. Biol. Hung. 20, (1977)*

HUNGARIAN INVESTIGATIONS CONCERNING GROWTH AND DEVELOPMENT AND THE VARIATION OF PHYSIQUE
(Opening lecture)

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A hundred years ago, in 1876 was organized the first international meeting in Budapest, Hungary under the title of International Congress of Physical Anthropology, Archaeology and Prehistory. According to the scientific interests of that time the Congress primarily discussed the key problems of palaeoanthropology. Nevertheless, Samuel Scheiber took the opportunity to lecture on "the average stature of Hungarian males".

As far as growth and development of children are concerned, the first Hungarian investigations also look back upon a hundred years of history. The beginning of Hungarian examinations of variations in physique date from 1884 when Bertalan Stiller published his work. It is in the spirit of our predecessors that we now organize the present Symposium under the title of "Growth and Development; Physique". Furthermore, at the end of the "summing up" phase of the International Biological Programme we undertook to create an international platform for the publication of results obtained in this field of research.

In the following please allow me to give you a brief survey of Hungarian investigations.

1. HUNGARIAN GROWTH INVESTIGATIONS

A period of about one hundred years, from the earliest investigations until today, can be divided into three epochs /Eiben 1972, 1976/:

a/ The first epoch embraces some 50 years starting with the first investigations /Kézmárszky 1873, Körösy 1875, Weisz/Földes 1875, Scheiber 1881/ and terminating with the First World War. These were mostly individual studies, poorly organized and coordinated, while the methods of investigation and analysis of data were not uniform. The investigations concerning development of children were frequently coupled with various other examinations, so that anthropological investigation in fact became secondary. Still it is the undying merit of the Hungarian researchers that, in recognizing the importance of the problem so early, they started the anthropological investigation of the body development of children and thereby outdistanced numerous big countries.

In that period the population of Hungary was far more sedentary, and rarely did people change their place of residence by comparison with today's population, and consequently, there was much less mixing. The environmental factors, social, economical conditions, and all the other factors issuing from these were generally poorer than the average we find today.

b/ After the First World War it was Bartucz /1923/ who produced a large number of data, and from here we identify the second epoch, comprising some 20 years, roughly the period between the two world wars. The first nation-wide data collection was followed by organized investigations both in the capital and in the country. This period witnessed the unification of methods both of investigation and analysis, so that from this time on the results of the examinations may be compared.

The environmental factors influencing the growth and development of children, - while they on the average did not significantly improve, nevertheless - changed. After the First World War the territory of Hungary was diminished to one-third of its previous area, and the country's population began to move about more than previously. At the same time with increasing capitalization and industrialization, urbanization became more intensive: the /relative/ genetic equilibrium of the population was upset. Social differences became more pronounced in the living conditions of the various groups of children, especially in going to work very early or late. Nutritional conditions also changed, since in the towns the diet was more mixed than in the villages where the consumption of carbohydrates, primarily cereals, was pronounced.

c/ The third epoch embraces the 30 years after the Second World War. After the war the difficult economic conditions greatly hindered the investigations of development of children, though quite logically the question was posed: to what extent did the war influence the growth of children? /Véli 1948/. This first study was subsequently followed by numerous methodical investigations. Their initiation and development are the merit of Professor Malán and his followers in Debrecen.

In this epoch the research workers realized the need of a nation-wide investigation, wherever possible carried out on large numbers of children. The methods of investigation and analysis are up-to-date. Besides these cross-sectional investigations several longitudinal experiments have started /Rajkai 1970/. The investigations on the whole are well coordinated, and since the 1960s most of them within the frame of the International Biological Programme, generally led by the University-Departments of Physical Anthropology. In recent years increasing interest has been shown by various other research workers in our work who wished to participate and contribute toward the improvement of our research, such as hygienists, school doctors, paediatricians, sports research workers, psychologists, teachers of backward children, etc.

The environmental factors influencing the growth, development and maturity of children significantly improved by comparison with earlier periods. The most important fact is that this improvement is of general validity covering all social classes and strata, and conquently every group of children. Socialistic industrialization increases urbanization, this means the movement of large masses of people, biological mixing becomes significant, the genetical conditions of the population undergo further changes.

2. HUNGARIAN PHYSIQUE RESEARCH

It is the merit of a Hungarian author who first recognized and described the most characteristic type of physique, the asthenia, thereby laying the foundation of physique research combined with illnesses and various complaints. Bertalan Stiller /1837-1922/ was a keen-sighted observer and this capacity was fortunately coupled with a scientist's profoundeness. In his work titled "Az ideges gyomorbántalmak" /Nervous stomach ailments/ published in 1884 he first sketched out his observations, then in 1907 in another work titled "Az astheniás alkati betegség. Asthenia universalis congenita" he summed up his findings. /Later in 1916 in his "Grundzüge der Asthenie" once again he discussed the problem./ Though Stiller overvalued the significance of "floating rib" /costa X. fluctuans/ and considered asthenia as an illness, his morphological description of asthenia is still a classic today.

Károly Csörsz who died early was an excellent population geneticist. He proved on the basis of the examination of a whole village population heredity of the two important syndrome of asthenia: palpable kidney and costa X. fluctuans.

László Buday was a first-class expert in clinical experiments. He extensively analyzed variations of physique. His "Orvosi alkattan" /Medical textbook on physique/ published in 1943 is a very useful handbook.

Research between the two world wars continued with the methods of Viola's somatometry and Kretschmer's somatoscopy. Accordingly the classification of physique was made on external body morphological features, and it mostly gained application in clinical practice and in the science of physical training /this was the beginning of the so-called sport anthropological investigations/. Sheldon's somatotyping appears rather late in the 1960s in the Hungarian special literature.

After the Second World War investigations concerning physique variations in our country began at a slow pace. Since the beginning the 1960s, however, they gained impetus. In the last decade factor analysis has become just as much a part of physique research as is the analysis of physique by tissue components. And with these we reach the research of today.

Respectfully we think of the works of our predecessors. We regret that our professors and the recently mentioned co-workers /L. Bartucz, M. Malán, T. Rajkai, M. Fehér and others/ may not be with us here at this Symposium. If we are today able to show results we must acknowledge our debt to their works, from which our own derives.

On the opening of this Symposium respectfully I greet you all. I wish you a fruitful exchange of information and discussion. I am more than certain that you will all benefit from this meeting and that your knowledge will be enriched with new thought-provoking ideas which will further universally the investigation of human biology. The same I can certainly say for my country. Bearing this in mind I ask you to actively participate in the discussions. Once again I wish you all the very best during our sessions!

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GROWTH AND DEVELOPMENT

Growth and Development; Physique *Symp. Biol. Hung. 20, (1977)*

GENETIC AND ECOLOGICAL CONTROL OF HUMAN GROWTH

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Genetic determination of continuously distributed traits can not be understood without an analysis of environmental factors acting during their development. The effect of the environment on the organism cannot be understood, on the other hand, without a knowledge of the genetic predispositions of given individuals. The environment for a cell is another cell, or conditions present in the lungs or the digestive tract as well as those outside the organism. In fetal life the intrauterine environment is an additional important factor.

The interrelationship of the organism with the environment is determined by a complex of genes which are responsible for a given tissue sensitivity. The non-specific immunity and resistance of the organism and the mechanisms of development of specific immunity are similarly genetically determined. Finally, the intake of food is regulated in part by genetically determined gustatory sensitivity. It seems also that predisposition to assimilation of certain substances from the digestive tract is controlled genetically at certain levels.

Similarity of relatives: genes or environment ?

The genetic similarity between the parent and offspring, randomly selected sibling pair, or dizygotic /DZ/ twins is identical, amounting to 50% of genes. However, the environment in which a DZ twin pair is growing is nearly identical, that in which two successively born /at a small time interval/ children are growing is very similar usually, but the environment of parents and offspring at developmental age differs considerably.

Because of that, the correlation coefficients between the traits of DZ twins are overestimated with regard to genetic similarity. They are sometimes twice as high as those between a randomly selected sibling pair, and between the siblings they are several percent higher than between parent and child /fig. 1/.

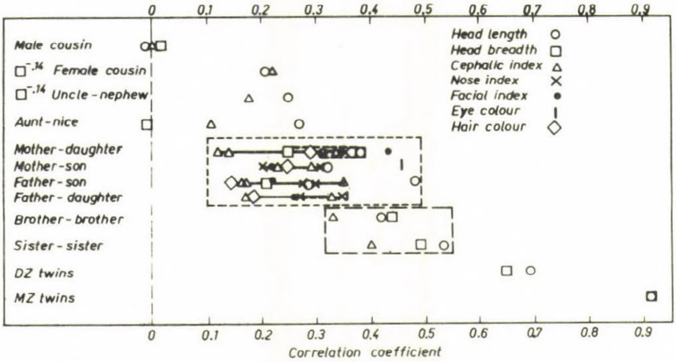
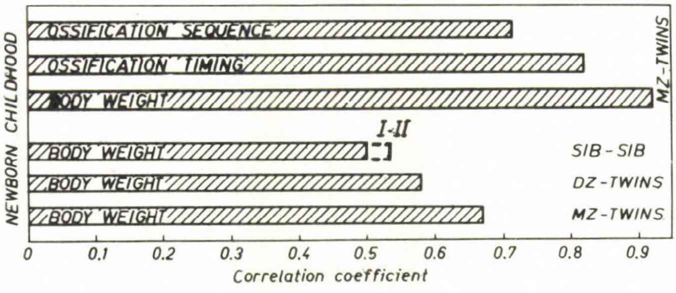


Fig.1. Correlation coefficients of some cephalometric traits, hair and eye colour between different relatives /above/ and of body weight and ossification between MZ, DZ twins, 1st and 2d born child /I-II/, and random siblings /sib-sib/, /under/. /Data from Pearson, Lee 1903, Newman at al.1927, Ikeda 1953, Furusho 1964, Wolański, Charzewska 1967, Wiercińska 1969, Wierciński 1969, Czesnis 1971/.



The problem arises now whether a similar additive influence exist in the action of poly meric genes on con tinuous distribution traits since the section of environmental factors is analogously additive.

Two populations not differing in the frequency of genes /Wolański and Jarosz 1969/: an urban population with a high standard of living and nutrition, and a rural one from poor villages showed differences in the similarity of traits between the offspring and their parents /fig. 2/. Higher correlation coefficients in the parent-child relation were found in families with lower standard of living than in those with a higher standard /Charzewska and Wolański 1964/. Two years later the results of these investigations were confirmed by Bainbridge and Roberts /1966/, and Bielicki and Welon /1966/. The latter authors obtained analogous results studying poorly nourished groups living in urban areas /fig. 2/. The same results is obtained comparing the data reported by Garn and Rohmann /1966/ for optimal life standard in USA with the data of Pearson and Lee /1903/ for groups with a low living standard in England in parent-child as well as sib-sib relations /fig. 2/.

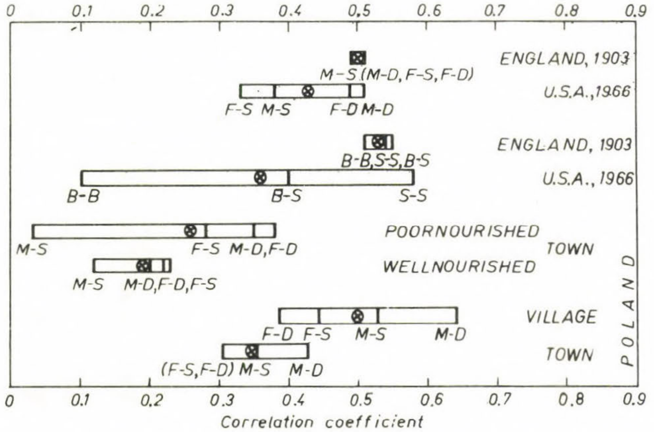


Fig. 2. Correlation coefficients for stature in Poland: town and village /Charzewska, Wolański 1964/, poor- and wellnourished town families /Bielicki, Welon 1966/; USA /Garn 1966/; England /Pearson, Lee 1903/. F-S= father-son, F-D=father-daughter, M-S=mother-son, M-D=mother-daughter, B-B=brother-brother, S-S=sister-sister, B-S=brother-sister correlations.

The question of genetic interpretation of these facts has been put forward. In connection with the views mentioned above Bielicki and Welon /1966/ and Tanner et al. /1970/ suggested the simplest explanation that correlation coefficients decrease due to changes in the participation of the environmental component in phenotypic variability. That means that the similarity of the living standard of children in relation to that of their parents in childhood has diminished since the parents moved to higher social strata. This probability is greater in families with good socioeconomic standard.

In fact, in the urban population /with higher standard of living the dispersion of traits is greater than in the rural population with lower standard and more similar conditions of life /Wolański and Lasota 1964/. It is known, however, that with greater variability of the trait, the correlation coefficients overestimate the actual parent-child similarity. On the other hand a homogenous material masks the distinctiveness of correlation which could be obtained under optimal conditions for heritability /Płochinski 1964/. It is known, furthermore, from experiments on animals that with unification of the environmental component the individuals with favorable breeding traits are not able to develop to an optimum while under better conditions the phenotypic differences between individuals are decreasing. Under good economic conditions the more or less enterprising men can equally well earn their daily bread. The earnings above an indispensable minimum are without significance for the mode of nutrition. This shows that under worse conditions of life the genetically determined individual traits manifest themselves not less well than under conditions of optimal feeding and living /Johansson 1953/.

It seems that not the general economic level but the degree óf differentiation of the nutrition and way of life in a population are of decisive importance for phenotypic differentiation. Because of that, we have put forward another hypothesis for explaining the fact that the similarity of traits in the parent -child and sib-sib relations is greater when nutrition is poorer and lesser when nutrition is better and more differentiated /Wolański and Charzewska 1967, Wolański 1970/. We belive that less evident similarity of children to their parents under conditions of good nutrition is due to greater and wider possibilities in using different metabolic pathways in view of greater and amount of various nutritional components /fig. 3b/. On the other hand, when the offspring ascend to higher socioeconomic strata their traits adapt themselves to better feeding and achieve a higher level of development which is not necessarily connected with a change in their position in relation to their parents /fig. 3a/ and because of that the correlation coefficient remains unchanged /Wolański 1974/.

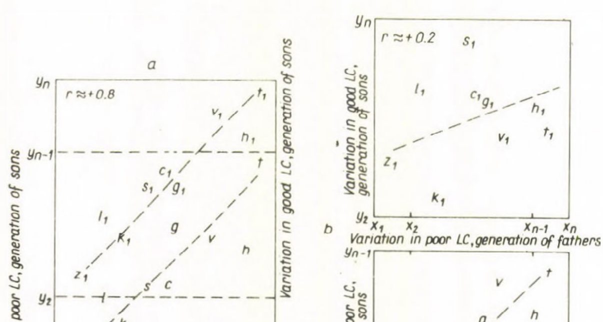


Fig. 3. Expected correlation coefficients between father-son in poor living conditions /LC/ of father and poor or good LC of son - if random /a/ shift of subjects to better LC or if a change /b/ in position within the group due to different developmental pathways /Wolański 1974/

The hypothesis on the effect of increase in social status on a decrease of the parent-child correlation has been refuted rerently by its authors /Bielicki and Charzewski 1975/ demonstrating that correlation coefficients between the height of parents and their children in socially rising families were identical to those in families who had not risen socially. This was to be expected since environmental changes which took place in a period of two successive generations have been great /in Poland at least/ with regard to both discussed types of families.

On the other hand, reports have been published recently /Mueller 1976/ suggesting that the parent-child similarity is greater particularly in the well-off classes because both generations can achieve their genetically determined possibilities. As an evidence for this the range of fluctuations of correlation coefficients in the European and non-European populations, as well as in the allegedly well- and malnourished populations has been demonstrated /fig. 4/. A comparison of Mueller´s own data /1976/ with those from the USA and Colombia showed, however, higher correlation coefficients /fig. 4/ in the population with less well nutritional state. Comparisons made between the USA and England according to years of determination /upper part of fig. 4/ indicated that with increasing living standard in the USA, the parent-child correlation coefficients decreased. In view of this the data of Mueller confirmed the results obtained previously in Polish materials.

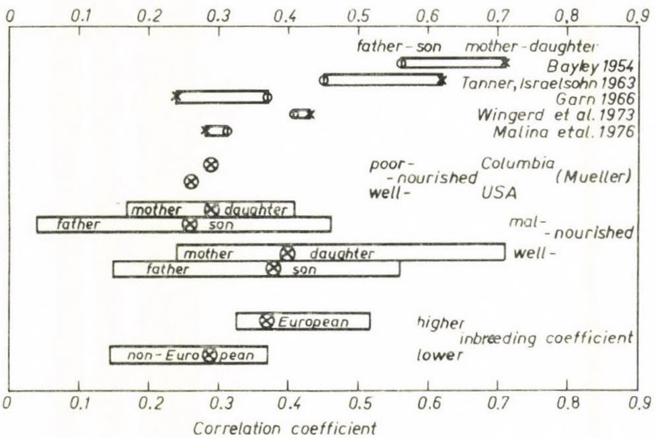


Fig. 4. Correlation coefficients between parent-child, in European and non-European populations, in well- and malnourished populations from different countries /all data from Mueller 1976/, in USA and Colombia; and in USA and England from 1954 to 1976 /sources in figure/.

Higher correlation coefficients in the European populations as compared with the non-European ones may be due to quite different causes. It is known that positive assortative mating and consanguinity exert an effect inflating heritability. If inbreeding is lower in the non-European populations compared by Mueller /New Guinea, Colombia, Japan, Peru/ than in the European ones /USA, England, Poland, Czechoslovakia/, this explains lower correlation coefficients in non-European populations.

The possibility of changes in correlation coefficients between relatives depending on external environmental factors is evidenced also by the results obtained in the Japanese populations in 10 years of investigation /fig. 5/. A shift occured from positive correlation coefficient for stature between 6.5-year-old brothers in the years 1941-1950 to negative coefficients in the years 1949-50, while in the 10.5 year group a reverse shift occured from negative to positive values. The cause of this shift may be e.g. developmental acceleration which took place in this time period or the cause might have been socioeconomic changes in Japan during the war and in post-war years.

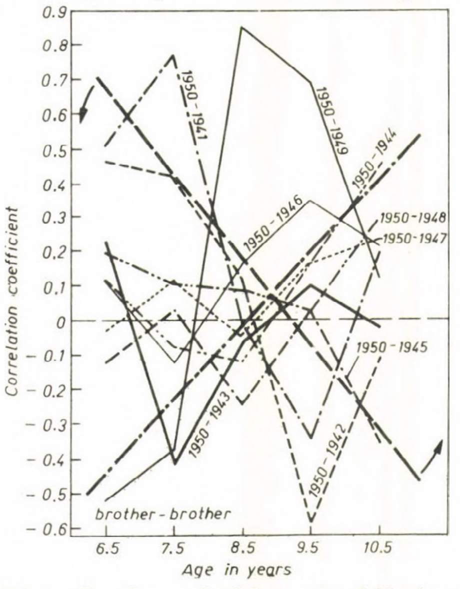


Fig. 5. Correlation coefficients between brothers in Japan in different years /data from Furusho 1963/.

Genetic control of ecosensitivity

Another problem is the genetic determination of organism sensitivity to environmental factors, so-called ecosensitivity. The investigations up to now were concerned with the degree of heterozygotism, sexual differences, differences connected with the phase of ontogenetic development, individual traits and sides of the body /lateralization/.

Under conditions of good nourishment the heterozygotic offspring are taller than the homozygotic offspring raised under analogous conditions from the standpoint of a given trait in parents /Wolański 1974, fig. 6/, similar results had been obtained earlier by Garn /1962/ but they were not interpreted then in this way. On the other hand, heterozygotic offsprings raised under unfavourable conditions /malnutrition/ have lower stature than homozygotic offsprings in similar conditions /fig. 6/. The heterozygotic individuals are much more sensitive to environmental factors /ecosensitive/ than homozygotic individuals. Men react with decrease in height to moderate undernourishment while women respond in this way only to high-grade disturbances of living conditions /fig. 7, Wolański 1975/. When the conditions of life improve /e.g. realimentation/ men are first to respond with increased height while women respond later /fig. 7/. This confirms the hypothesis that men are more ecosensitive. In women, it is more difficult to change the actual pathway of development but when this change has taken place it is more persistent and more difficult to return to its previous pathway. It is possible that this is due to stronger determination of females who have two chromosomes X /perhaps inactivation of one of them does not concern all its manifestations/. The fact that males possess the XY heterochromosomes is possibly the reason for the greater proneness of males to adapt themselves to environmental conditions.

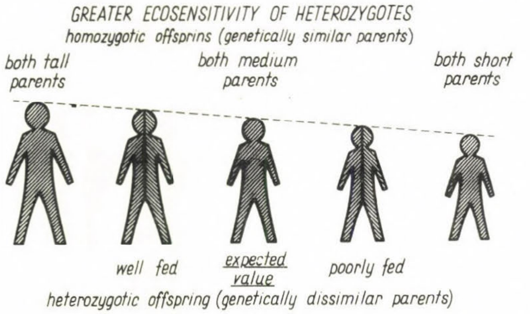


Fig. 6. Heterozygotic offspring of genetically dissimilar parents living in poor LC are shorter than expected, and living in good LC are taller than expected - if both parents are medium and live in similar living conditions.

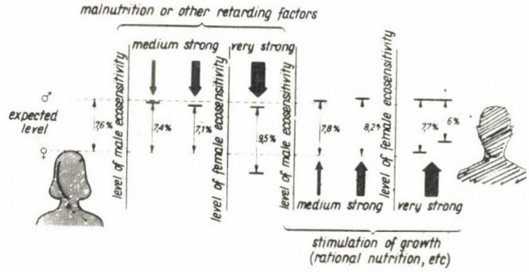


Fig. 7. Per cent differences in stature between males and females under various living /nutritional/ conditions /Wolański 1975/.

Traits developing mainly in postnatal life are more sensitive to environmental influences /Wolański 1974, Kasprzak and Wolański 1975/. It may be possible that determination of development and metabolic processes in the stage of prenatal development have an effect enhancing the genetic stabilization of the developmental pathway also in the postnatal period.

The analysis of Holtzinger´s index suggest that the development of bones is most strongly determined genetically, followed by adipose tissue, muscles and bone marrow /as judged from the cross-section of marrow cavity - fig. 8/. The development of distal phalanx is usually most strongly determined genetically followed by proximal phalanx, wrist, forearm and arm /fig. 8/. This sequence is opposite to the cephalocaudal sequence of development: the traits developing earliest show the least heritability and those developing latest show greatest heritability. This is an unexpected result. A similar mode of heritability assessment was applied by Spuhler /1962/ obtaining similar results. The analysis of his data shows that the strongest genetic control is exerted upon stature, followed by dimensions of the feet and hands, height of the face, body weight, breadth of the face and nose, while the diameters of the trunk are least influenced /fig. 9/.

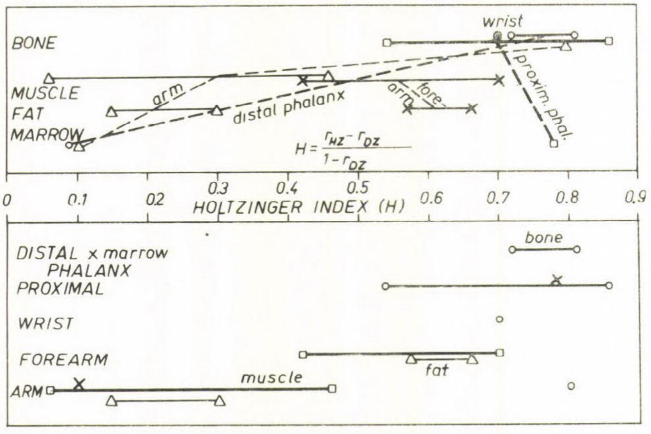


Fig. 8. Holtzinger index of heritability for different segments of upper extremity and for different tissues /data from Nikityuk 1973/.

On the basis of parent-child correlation we tried to assess in another way the heritability of somatic, physiological, biochemical and psychomotor traits. The traits de-monstrating greatest genetic determination include /fig. 10/ muscle power and time of simple reaction. The traits determined genetically above the medium degree are: psychomotor coordination, eye-hand movement coordination, velocity of movements, enzymatic activity, equilibrium sensation and head dimensions. The traits exhibiting medium degree of determination are: the dimensions of the body, the blood pressure, the endurance fitness. The traits controlled less strongly are the thickness of adipose tissue and dimensions of hands and feet. The accuracy of movements shows only small parent--child similarity. Among the somatic traits the head dimensions are more similar in the parent--child relation than the dimensions of hands and feet. These observations are contrary to the above mentioned results based on heritability assessment from the analysis of variance between MZ and DZ twins /indices of Holtzinger and Spuhler/. This points to the

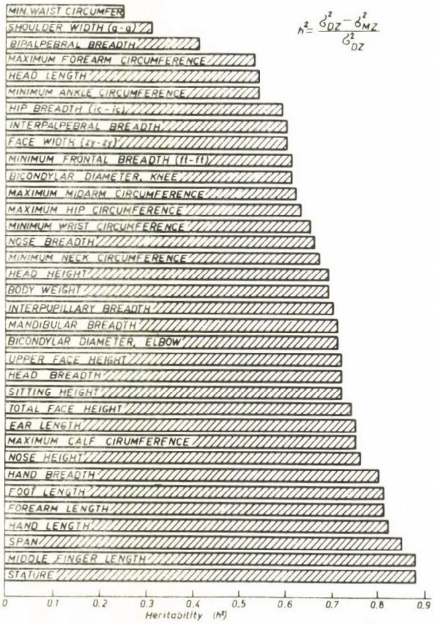


Fig. 9. Spuhler index /h^2/ of heritability of some somatic traits /data from Spuhler 1962/

unreliability of the presently used methods and causes that investigations based on twins are viewed with scepticism /Lerner, Mather and Mortin in 1962 WHO discussion, Dobzhansky, Penrose and many others/. Because of that, the search for new methods of assessingthe genetic determination of traits is continuing. By that method we could establish that timing of teeth eruption is more strongly controlled genetically than the sequence of eruption /Wolański and Jarosz 1969/. This contradicts the results obtained by the

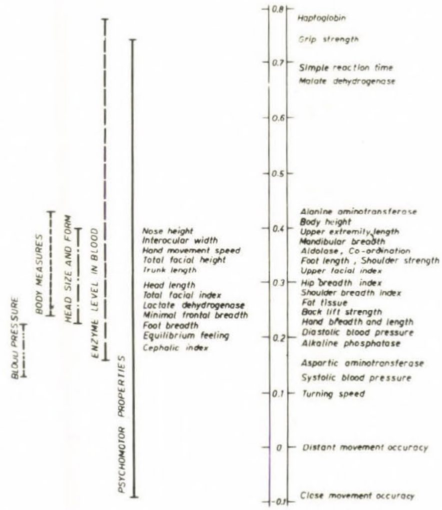


Fig. 10. Midparent-offspring correlation coefficients for different traits in Polish rural populations.

parent-child method /Garn 1962/. Garn studied a homogenous American population, in our investigations we compared rural and urban populations where the frequency of earlier eruption of I_1 and M_1 is considerable. The obtained results may be, perhaps, modified in different degrees by environmental factors.

Our method is based on the comparison of genetic differences /between women and men/ with environmental /Wolański and Jarosz 1969/ or with the whole phenotypic variability /fig. 11/. The data obtained by this method suggest that the thickness of adipose tissue and respiratory traits such as chest structure, as well as the traits of the cardiovascular system, somatic and blood traits /are genetically strongly determined/ the three last groups of traits are similarly differentiated/. The adipose tissue shows also significant sex-dependent differences as well as interpopulation differences, that is the traits is at the same time strongly determined genetically and is strongly influenced by nutrition and motor activity. This may explain differences in assessment of genetic control of this trait by various methods.

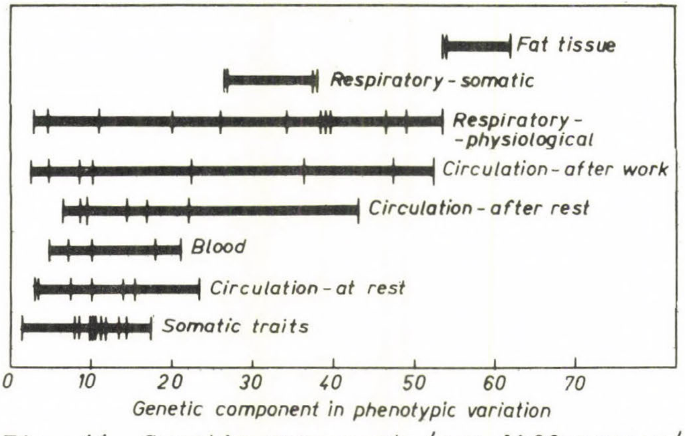


Fig. 11. Genetic component /sex differences/ in phenotypic variation /SD/ for some somatic and physiological traits in 3 Polish populations in different living and climatic conditions.

The postexertional or maximal sizes are usually much more strongly controlled genetically than resting sizes /fig. 12/. During rest the organism shows thus a much greater adaptation to environmental factors, while during exercise genetic differences become more evident.

Presence of asymmetry already evident in infants /Wolański 1957/ and lack of increase of relative asymmetry with age /Wolański 1972/ pointed to its genetic determination. This was confirmed by greater similarity of the motor function of the right hand than the left hand in the parent-child relation /Wolański and Kasprzak 1976/. It has been pointed out already by Galton /1886/ that tall people are somewhat less fertile or more frequently sterile /Furusho 1964/. On the other hand, it has been established, however, that taller people have higher survival value than short people, and that individuals dying at an earlier age are significantly shorter than the surviving ones /Conterio and Cavalli-Sforza 1967/. Both these mechanisms lead finally to repeteability of medium stature between the generations in a population, if tall people are less fertile but live longer and short people are more fertile but live less long.

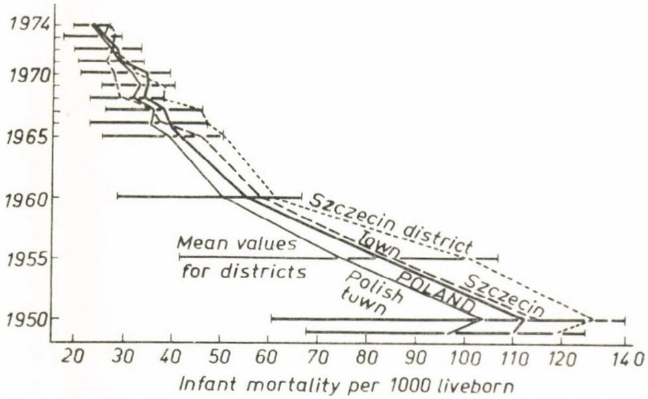


Fig. 17. Infant mortality indices in the city and district of Szczecin, for Poland as a whole, and for Polish towns from 1949 to 1974.

In the light of the above observations it is easier to understand why in certain countries, particularly in small populations living in relatively optimal biogeographic conditions, the height has been stabilized for several tens of years at least /e.g. Yap Island in Micronesia - Hunt 1958, Tristan da Cunha - Marshall at al. 1971/. Another factor, but the same mechanism seems to be responsible for absence of secular trend of stature in particularly well-off social strata in England and the USA. This factor is optimal developmental feeding patterns in contemporary civilization.

The mechanism of rapid stature rise in Szczecin /Poland/ in the years 1945--1965 and less rapid rise after 1965 is more complex /Wolański 1970/. It is known that the highest mortality is observed among biggest and smallest featuses

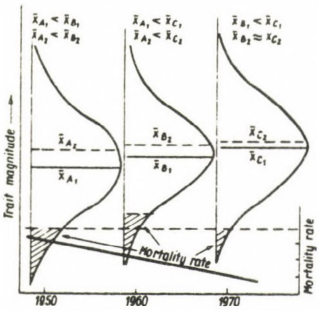


Fig. 18. Infant mortality related to the distribution of a continuous trait in Szczecin.

and because the mortality is much greater among the smallest fetuses /the distribution of body weight is highly negatively skewed/ this is the main factor influencing the value of the mean body length of infants in the whole population. The initially high mortality in this age group decreased later /fig. 17/. This shows how high losses of small fetuses and infants caused an increase of stature in the population. An additional factor responsible for height increase in this population was a high degree of crossbreading. In the years 1945-1947, 97% of the population of Szczecin had been exchanged and the mean radius of crossbreeding was 270 km /Wolański et al.1970/. With the relatively high standard of living of this population and high exogamy the stature of the population increased rapidly /Wolański at al. 1968/. This process came, however, to a stop when relaxation of selection against low stature individuals developed /fig. 18/. Despite a further increase of the living standard of the population, decreased mortality of low-stature individuals has led to much smaller stature increases in successive age groups of children.

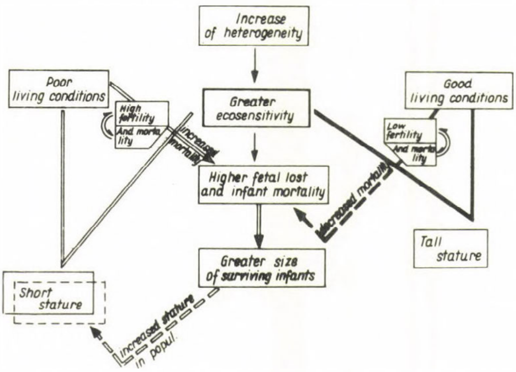


Fig. 19. Expected stature connected with living conditions and selective pressure /fetal loss and infant mortality/.

In India a stature decrease is observed in successive generations due to worsening of feeding pattern /low intake of animal protein/ and relaxation of low-stature individuals selection /Ganguly 1976/ connected with a drastic reduction of mortality. Due to high homozygosity of castes, the exogamy is probably reduced which may decrease the effect of unfavourable conditions of life.

Increasing fertility is observed usually in poor living conditions which also increase the mortality /Frisancho et al.1975/ and decrease the stature of individuals. However, increased mortality of weaker and smaller fetuses causes in the whole population an increase of stature above that which would be caused by poor living conditions /fig. 19/. This effect is not observed in good living conditions. Improved standard of living increases the stature only to a certain limit but at the same time the fertility and mortality decrease and the selection of low-stature individuals decreases as well. Rising migration and breakdown of intrapopulation isolation increase the heterogenicity and is a source of greater selection of offspring of parent with great genetic differences. In the developed countries the infantile mortality has been reduced to below 2% and the still persisting early mortality depends on genetic factors and cannot be prevented by improved environmental conditions but rather by better genetic counseling.

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SOME GENETIC AND ENVIRONMENTAL PROBLEMS OF PHYSICAL GROWTH AND DEVELOPMENT OF CHILDREN AGED 0–7 YEARS

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The physical growth and development of the child, determined by endogenic /genetic and paragenetic/ factors, is modified by a vast complex of exogenic factors including ecological ones, It is necessary to examine the influence of both kinds of factors on the physical development of the same group of children observed longitudinally. The paper to be presented now is just such attempt at comprehanding both the endo- and the exogenic development mechanisms on the basis of 7-year longitudinal investigations of a group of Lublin children.

Material and Method

The material was provided by longitudinal studies of 180 children /90 girls and 90 boys/ born to parents living in the city of Lublin, between september 1964 and may 1965 and examined periodically from birth up to the age of 7. The examinations of newborns were conducted in obstetrical wards, later they had control examinations in the Growth Clinic, every month in the first year of life and every 3 month in the following years. Each visit in the Clinic consisted of medical examination and anthropometric measurements. Information concerning the socio-economic situation of the family was recorded periodically. The parents of each child were also measured and weighed. The dates of all control examinations were fixed within range of tolerance accepted for each individual age group.

Up to 18th month the anthropometric measurements taken were supine length, later - stature; the fermer was taken with Wolański liberometer, the latter - with Martin anthropometer.

Owing to the longitudinal character of the studies the correlation between parents and children could be observed from birth up to the age of 7. Since body height is regarded as a feature largely determined genetically the relationship between the height of parents and their children was investigated. Besides height, the investigation included body weight. The relationship was expressed by means of correlation coefficient. Besides correlation on single parental features there were calculated multiple correlations of child on a pair of parental features /e.g. height of daughter - height of father and mother/. The parent-child correlation was investigated at birth, at 3, 6, 9, 12, 15 and 18 months, then at 2, 3, 4, 5, 6 and 7 years. The correlations were calculated between father-son /F-S/, father-daughter /F-D/, mother-son /M-S/ and mother-daughter /M-D/ at each age.

Results and Discussion

It has been found that the closest correlation occurs between mother and daughter. The body height of daughters in the whole of the whole of the investigated period depends significantly on the stature of mother /Fig. 1/. This relationship is already observable at birth: the

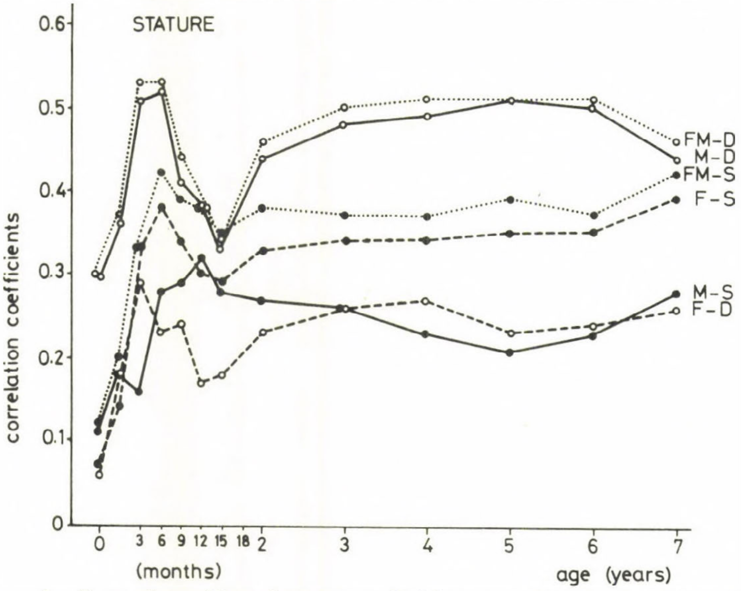

Fig. 1. Parents-offspring correlation coefficients for stature.

correlation coefficient between the supine length of a female newborn and the stature of mother is significant /r=0.30/. The mother - daughter correlation for stature increases with age, achieving its peak at 9 month, declining temporarily between 15 and 18 months and going up again in 2nd and further years of life. The correlation between the stature of father and daughter is considerably lower but this, too, increases with age. The low father-daughter correlation is confirmed by multiple correlation: the stature of father combined with that of mother /FM-D/ does not increase significantly the correlation coefficient between daughter and both parents.

The father-son correlation for stature is significant only starting with the age of 6 month. The likeness between father and son is observable starting with 9th month producing significant correlation coefficients. Though the mother-son correlation is weaker than father-son, yet is exercises influence on the multiple correlation of son on both father and mother, which increases significantly.

The similarity of children to parents in weight is considerably lesser /Fig. 2/. The mother-daughter correlation for body weight is

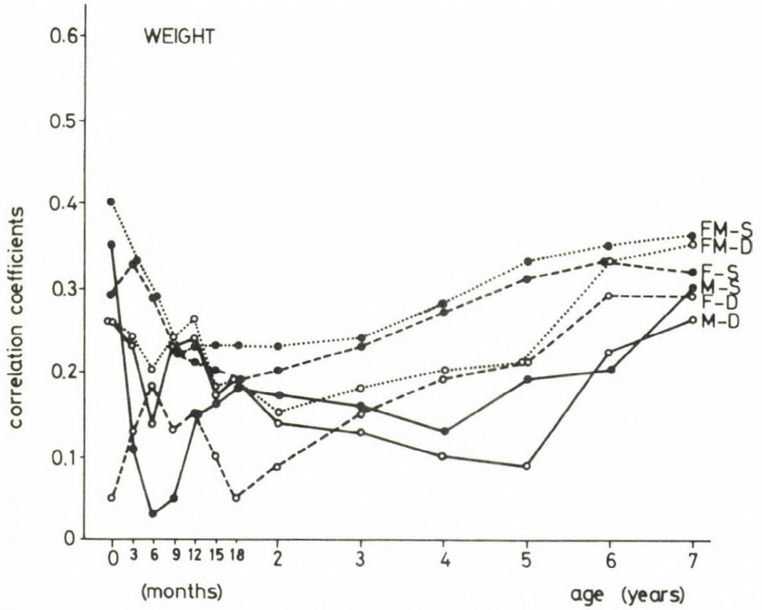

Fig. 2. Parents-offspring correlation coefficients for body weight.

significant only in newborns, at 3, 9, 12 months and at 7 years. In all the other age groups the correlation coefficients are very low. The father-daughter correlation coefficients are significant only at 6 and 7 years, though the multiple correlation on the weight of both parents increases the correlation coefficients at the age from 3 to 7. The weights of father and son are more clearly related, although the relationship is significant only in the 1st year and at the age 3-7.

The mother-son correlation for weight is slight and significant only in newborns and at the age of 7. It should be stressed that in body weight there is greater similarity between father and son, and at the age 3-7 also between father and daughter than between mother and daughter. Another important observation is that there is a high correlation for weight between mother and newborns of both sexes and that it decreases up to 6th month. This could be expected because body weight in newborns depends largely on intrauterine factors and only slightly on the genotype /Penrose, 1961/. Subsequent correlation coefficients increase with age.

As was pointed out earlier, the correlation coefficients for body height of parents and children /F-S, F-D, M-S, M-D/ are the lowest at birth, which indicates that genetic determinants affect height only slightly in the stage of foetal development.

Many authors /Penrose 1955, Robson 1955, Wolański 1967, 1970/ stress that the intrauterine development is affected very strongly by the individual peculiarities of the mother, so much so that the genetic. dispositions of the foetus are stifled in a way. Only in later stages does the child's genotype exercise an increasing influence and the similarity in physical growth to the parents becomes more observable.

Numerous authors unanimously confirm the increasing correlation between the features of parents and offspring as the latter develop /Kagan and Moss 1959, Livson et al. 1962, Tanner and Israelsohn 1963, Furusho 1964, Susanne 1971/. However, the results of different authors evaluating the degree of parent-offspring correlation during growth vary. In the present investigations the results come closest to those of Tanner and Israelsohn /1963/.

It is indicated by literature and by the results of the present studies that the mother plays the dominant role in shaping the features of the offspring. It seems probable that the maternal regulator not only determines the foetal development but also affects the metabolism in post-natal growth and development /Qunsted and Qunsted 1966/.

The next factor taken into consideration was the influence of the mating type of parents on child's growth and development.

To find to what extent the mating type of parents influences height of offspring mean arithmetic values of sons and daughters were compared in separate categories of this feature in parents /Fig. 3/. Three categories of stature were distinguished and marked: 1. short, 2. moderate, 3. tall. This produced 9 possible combinations of stature in couples

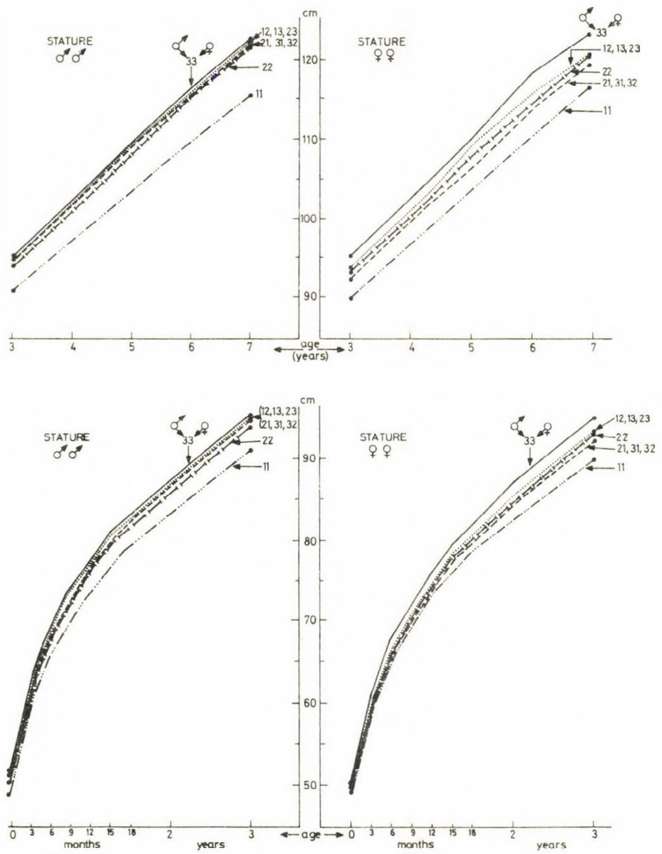

Fig. 3. Growth curves of stature in boys and girls in relation to mating type of parents.

grouped in the following way: a/ homological groups - 1. both spouses short, 2. both spouses moderate, 3. both tall, b/ heterologic groups - 4. mother in taller category of stature than father, 5. father in taller category of stature than mother.

It was found that in all age classes over 3 months the offspring /both male and female/ of tall parents are the tallest, the offspring of short couples - the shortest, whereas the offspring of parents of moderate stature also reach middle height. What is interesting, is the stature of the offspring of parents in heterological grαups. The sons of parents who belong to different categories of height are taller than the sons of moderate parents in all age groups after 3 months. Both sons and daughters of couples where the mother is in the taller category than the father are taller than the offspring of tall fathers and short mothers. This phenomenon can be better observed in females. Daughter of couples where the mother is in the higher category of stature than the father grow taller than daughters of moderate couples and inversaly, daughters of couples where the mother is in the lower category of stature than the father are invariably shorter than daughters of moderate couples. Those findings confirm a strong influence of the mother's genetic factors which is more marked in daughters.

Further, an attempt was made to determine the share of paragenetic factores such as the age of parents and the birth order in the child's development. Mean arithmetic values of body height and weight of offspring were compared mutually in separate categories of age of parents. As the mean arithmetic values in corresponding categories of features of boys and girls were similar, they were considered together for both sexes. The results obtained show a slower development of the offspring of the youngest mothers aged under 20. The highest stature was that of

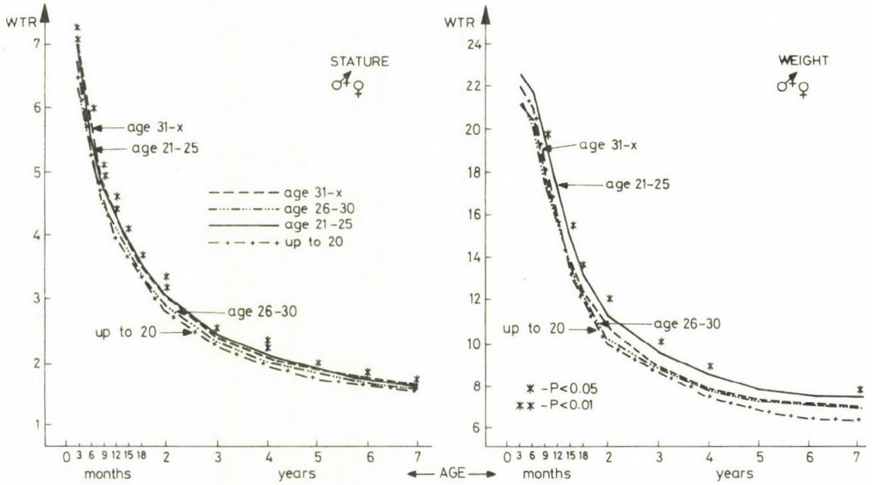

Fig. 4. Growth rate of stature and weight of children in relation to mother's age.

offspring of mothers aged 21-25 and over 30 /up to 41/;the highest weight was achieved by offspring of mothers aged 21-25. This regularity has been confirmed by an analysis of the rate of growth of offspring of mothers in the same age categories /Fig. 4/. The differences between mean arithmetic values are statistically significant in many age classes. Thus it seems on the basis of the present analysis that the best child-bearing age of the mother is 21-25, whereas the age below 20 affects the growth of offspring adversely.

When birth order was investigated it was found that first-borns are lighter and shorter than second and further children. Up to 18h month the tallest and heaviest are second children. From 18th month till 6 years the slowest physical development was found in 3rd and further children. An analysis of the rate of growth /Fig. 5/ showed that in the whole investigated period the fastest growth, bowth of body weight and height, occured in first-borns, the slowest - in 3rd and further children. The differences are statistically significant in many age classes.

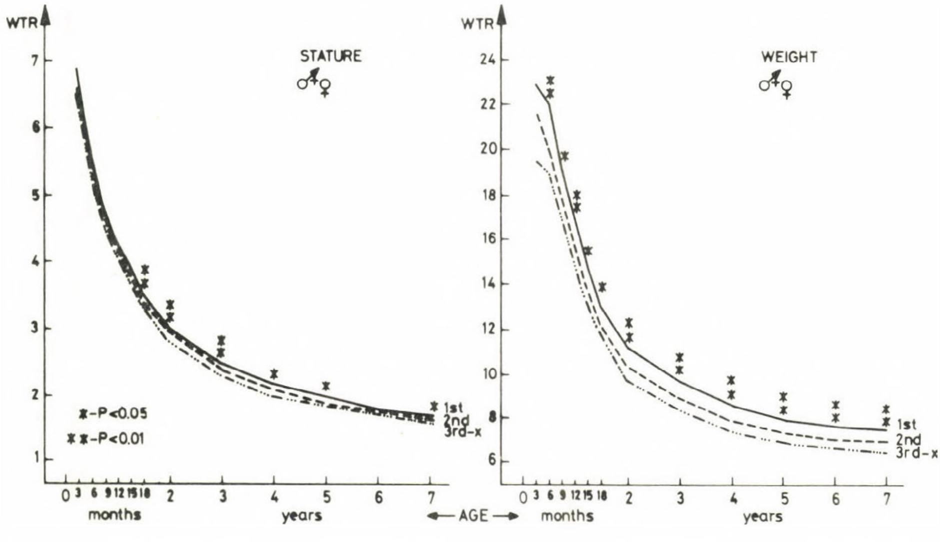

Fig. 5. Growth rate of stature and weight of children in relation to birth order.

When the influence of environment was considered only those factores were discussed which significantly influenced the height and weight of male and female children. It was found that there is a clear connection between the height and weight of child and the number of persons in the family as well as between the number of persons per 1 room. The factor that best characterizes the complex of socio-economic conditions is the monthly per capita income /Fig. 6/. The best physical development was found in children of parents with highest income, whereas

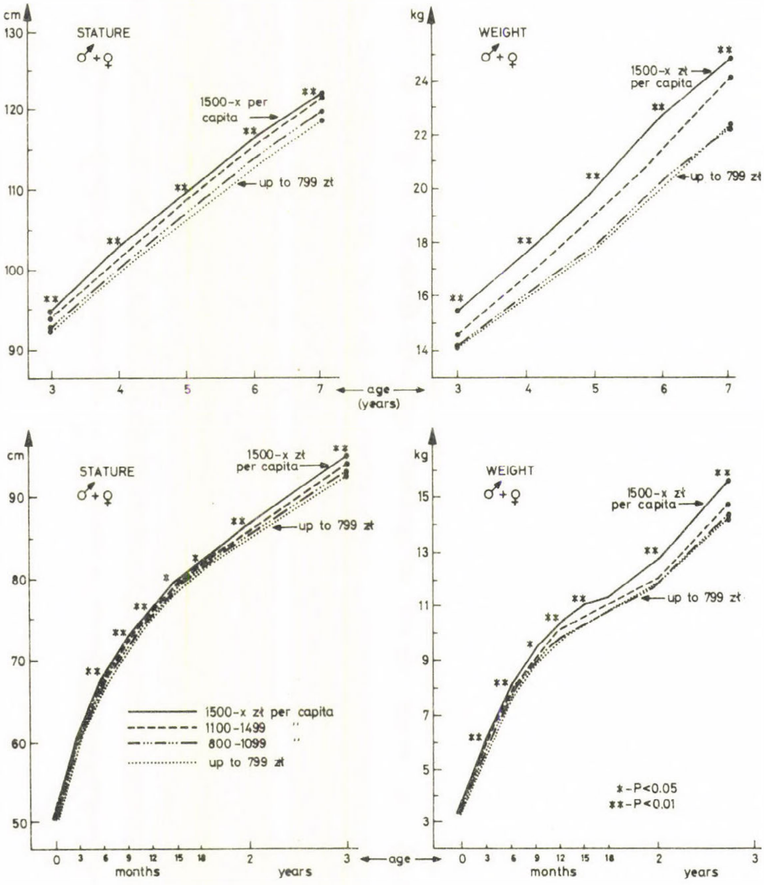

Fig. 6. Growth curves of stature and weight of children in relation to per capita income.

children from low-income families achieve the lowest stature and weight. The difference in body height are statistically significant starting with 6th month, those of weight - already starting with 3rd month. The highly significant statistical differences is maintained in all the further age groups up to 7 years. The analysis of the socio-economic factors was based on those conditions which were found in the period of early childhood, i.e. from birth to 3 years, whereas later socio-economic changes were not considered. Nevertheless, the effects of the early conditions are observable in the whole of the investigated period. This confirm the well-known and often stressed fact that a child is especially susceptible to environmental factors in early childhood.

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THE INFLUENCE OF GENETICAL AND ENVIRONMENTAL FACTORS ON THE FEMALE ADULT HEIGHT

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It is a well documented fact that adult height (AH) is under genetical control. The role of socio-economic level (SEL) on the adult height is however still being discussed (Dreizen et al., 1967; Howe and Schiller, 1952). We have therefore investigated on two different socio-economic levels of mature Istanbul girls the social differences as well the relationship between their mature height and that of their parents. The results and conclusions achieved will be presented on this paper.

Material and Methods

The material consists of 45 girls from the upper and 54 girls from the low-middle socio-economic level of Istanbul and of their parents. The standing height of the parents as well as of girls were measured by the same scale and person.

The adult height was assumed in girls to have been attained in the longitudinal study when no increase in stature was observed in two successive six month intervals and also when fusion of all hand and wrist epiphyses had occured.

Results

The mean and S.D. values of standing height in girls as well as of their parents in two different SEL and the statistical analysis of the differences in groups are presented in

Table 1. Adult height of parents and daughters in two different socio-economic groups and the significance of the differences.

	N	Mothers		Daughters		Fathers		Difference: daughter-mother			
		m	S.D.	m	S.D.	m	S.D.	m	S.D.	t	p
Kolej	45	159.71	5.71	161.92	5.54	171.13	5.62	+2.21	5.59	2.463	<0.02
Silivri	54	156.13	6.33	157.91	5.91	168.42	4.70	+1.77	7.45	1.746	>0.05
Total	99	157.76	6.29	159.79	6.06	169.65	5.29	+2.03	7.00	2.804	<0.01
t		2.899		3.424		2.564					
p		<0.005		<0.001		<0.02					

Table 1.

There was a significant difference of 4.01 cm. in the adult height of daughters in favor of the high SEL. But the parents from the high SEL were also significantly taller than the corresponding values found in the low-middle SEL (Table 1).

The mature height of the daughters were in both SEL taller than their mothers. On the whole the daughters were 2.03 cm ($\pm$ 7 cm) taller, and this was significant ($p < 0.01$).

The Relationship Between the Adult Height of Daughters and Their Parents

The correlation between the adult height of daughters (D) and their parents in the total 99 families were significant. The relationships can be expressed by the following regression equations:

Equation	r	SE_y
(1) Ht (D) cm. = 93.55 + 0.42 (Ht. mother)	0.43	5.48
(2) Ht (D) cm. =100.58 + 0.35 (Ht. father)	0.40	5.57
(3) Ht (D) cm. = 40.47 + 0.356 (Ht. mother) + 0.37 (Ht. father)	0.54	5.16
(4) Ht (D) cm. = 59.38 + 0.61 (Ht. mid-parental)	0.46	5.39
(5) Ht (D) cm. high SEL = 5.84 + 0.94 (Ht. mid-parental)	0.70	3.96
(6) Ht (D) cm. low SEL = 77.23 + 0.50 (Ht. mid-parental)	0.37	5.50

Although the genetic relationships were all significant, the error in estimation from the best eq. (3) is only 0.9 cm. less than the general SD of the daughters height. According to eq. (4), for an increase of 1 cm. of mid-parental height, an increase of 0.6 cm is expected in the adult height of the daughter. But the SE is high (5.39 cm).

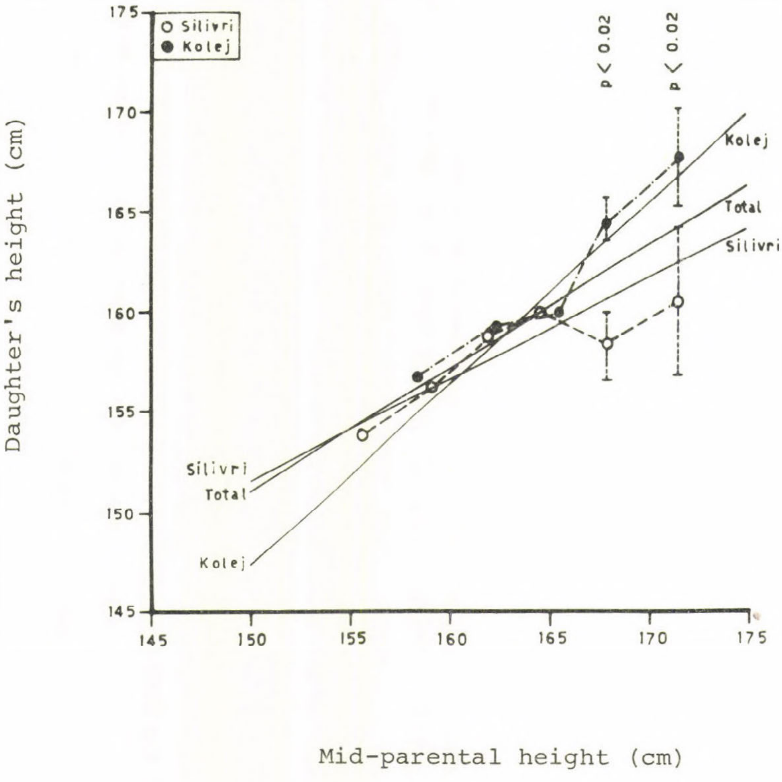

Figure 1. The relationship between the mid-parental height and the adult height of daughters in the high (Kolej) and the low-middle (Silivri) socio-economic levels. The correlation is lower in the low-middle level. The open and filled circles represent the mean of observed values. At the low-middle socio-economic level (open circles) the daughters height does not increase with increasing mid-parental height after 165 cm. and the differences in the socio-economic levels are significant at this upper part of the regression.

In order to investigate the socio-economic factor independant of the genetic factor, the relationships were studied separately in both socio-economic levels. The results are presented in figure 1 and eqs. (5-6).

The mean adult height of the daughters at different mid-parental height are plotted together with the regression lines in figure 1. Upto a mid-parental height of 165 cm., the differences in the socio-economic groups are not significant and follow the regression line of eq. (4). But when mid-parental height is over 165 cm., although there is a significant rise in the adult height of daughters in upper SEL with increasing mid-parental height, this is not observed in the low-middle SEL. The adult height of daughters attained, after a mid-parental stature of 165 cm., is significantly less in the low-middle SEL ($p < 0.02$). If all offsprings are compared from parents of over a mid-parental height of 165 cm. this becomes slightly more significant ($t = 3.031$, $p < 0.01$).

Discussion

Our results have shown that on an average the daughters are 2 cm. taller than their mothers. But the variation is great and they may be 12 cm. shorter or 16 cm. taller than their mothers. This finding is in accordance with the secal acceleration (Tanner, 1962).

Although the mature height of the daughters is significantly correlated with the parents height (eqs. 1-4) the standard error in prediction from the parents is high (5-5.5 cm.) The correlation becomes lower in the low-middle SEL.

The comparison of the expected values of daughters from the mid-parental values in the two SEL with those of observed values have shown that daughters in the lower SEL become in fact 0.94 cm. less, and in the high SEL 1.14 cm. more than the expected height. This adds up to a socio-economic difference of 2.08 cm. The total observed difference was 4.01 cm. in the two SEL. We may then accept that 2.08 cm. of that difference is really due to SEL and 1.93 cm. due to the differences in height of parents. These figures suggest that socio-economic factors do influence the adult height as much as the genetic factors.

According to our results in daughters of taller parents, one can coclude that the genetic potential may not be expressed under non-optimal poor environmental conditions. This also explains the poorer correlation found with mid-parental height in the lower SEL (eq.6).

Summary

The relationship of parental height to the daughter's adult height was investigated in 45 girls from the upper and 54 girls from the low-middle socio-economic level of Istanbul.

According to the results, the adult height of girls (159.8 ± 6 cm.) correlated significantly with mothers' ($r = 0.44$), fathers' ($r = 0.40$), both parents' ($r = 0.54$) and mid-parental stature ($r = 0.46$). Although the genetical correlation was significant, the individual variation was great (SD = ±5.1 to 5.5).

The daughters were 2 cm taller than their mothers, but the individual variation was also great (SD = ±7 cm.).

The correlation between the daughters' adult height and their mid-parental height was significantly higher in the higher socio-economic level. Adult height of girls with taller parents are significantly shorter in the low-middle as compared to the high socio-economic level. It is concluded that the genetical potential in stature may not be expressed under poor environmental conditions.

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SOCIOECONOMIC FACTORS AND HUMAN GROWTH – OBSERVATIONS ON SCHOOL CHILDREN FROM BREMEN

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I. Introduction

In the last seven or eight decades the German Physical Anthropology spent a considerable part of its research capacity in the investigation of the social distribution of anthropometric parameters like body height as well as in the discussion of the possible reasons for the partly very marked social distribution differences, which came out from numerous studies carried out in nearly all parts of the Germany before World War II. A detailed and critical review of this field of the German Physical Anthropology, the so-called Sozialanthropologie, has recently been given by STRASS (1976).

The main hypotheses which have been set up in order to explain the social differences e.g. in the destribution of body height are the following two:

The genetic hypothesis and the environmental hypothesis. Both should be described here briefly.

The genetic hypothesis is based on the assumption of a strong genetic control of body height and other anthropometric characters, which have been studied in this context, and says, that the social distribution differences of them are caused at least to a very great part by so-called "social shifting-effects" (soziale Siebung). As larger individuals were asserted to be generally more intelligent than smaller they had had better chances to advance in higher groups, so that in the course of time in these genes for the development of a higher stature were concentrated whereas the lower social groups lost such genes more and more. For further details see SCHWIDETZKY (1953, 197o).

The environmental hypothetis says, that these social distribution differences are mainly caused by nongenetic factors. This does not mean of course, that the importance of genetic factors for growth and development of human beings is denied, but it means,that because of the generally more favourable life conditions in the upper social classes the genetic informations for physical growth and development could be much better realized in them as under the conditions of the lower social classes. This hypothesis implicates also, that body height and all the antropometric parameters linked with it would be rather a kind of indicator for the development conditions of different social groups. And furthermore one could expect that anthropometric differences between social groups would decrease or even completely disappear in the same measure as life conditions between social groups approximate. Such an assumption was also expressed by JÜRGENS (1971) and still much earlier already by LENZ (1959).

In order to continue this not yet finished discussion we started a couple of appropriate studies in Mainz WALTER et al. 1975) as well as in Bremen. Some main results of the latter study will be demonstrated and discussed here.

II. Material and methods

Body height and body weight were taken trom a total of n = 949 male and female school children between 9;6 and 1o;5 years of age. All of them are of German nationality. They have been sampled from various school of Bremen. In addition to body height and body weight the ROHRER - Index was calculated for each of these children.

Sociological and economic data of the families of these children were obtained by a questionnaire, which had to be filled out by the parents. In this study, in which the data of n = 373 children will be considered, parental income, number of sibs and number of children per household are analyzed in their relations to the anthropometric parameters mentioned above.

III. Results

Table 1 shows body height, body weight and ROHRER-Index in first and not first born boys and girls. First born boys are somewhat taller and heavier than not first borns and show a little higher ROHRER-Index. First born girls are also taller, whereas weight and ROHRER-Index are lower. With exception of the ROHRER-Index ($p < o.oo1$) and the body height in boys ($p = o.o4$) these differences between first and not first borns are, however, statistically insignificant. Though similar observations were made by numerous other authors, a plausible explanation for these differences could not yet been given.

Tables 2 - 4 demonstrate for the totals of boys and girls the correlation values between body height, body weight and ROHRER-Index and respectively parental income (Table 2), number of sibs (Table 3) and number of children per household (Table 4). It is to be seen from these figures, that in all cases only very weak correlations are present; none of them ist statistically significant. Nervertheless it comes out in boys as well as in girls that with increasing parental income body height and body weight show a slight increase; the ROHRER-Index decreases in boys, whilst in girls an increasing trend is to be seen (Table 2). The positive correlation between body height and parental income resp. body weight and parental income may indicate a certain influence of socioeconomic factors on the development of these two anthropometric parameters, though this influence seems to be of only very little magnitude and is statistically completely insignificant.

In boys body height, body weight and ROHRER-Index decrease

Table 1: Anthropometric parameters in first and not first borns

Boys

	First borns n = 14o		Not first borns n = 136			
	$\overline{X}$	s	$\overline{X}$	s	t	P
Body height	142,3 cm	6,4	14o,8 cm	6,2	2,o77	o,o4
Body weight	33,6 kg	6,2	32,2 kg	5,6	1,276	o,2o
ROHRER-Index	1,161	o,143	1,141	o,125	11,98o	< o,oo1

Girls

	First borns n = 1o4		Not first borns n = 128			
	$\overline{X}$	s	$\overline{X}$	s	t	P
Body height	14o,2 cm	6,1	139,8 cm	6,1	o,314	o,75
Body weight	31,8 kg	5,1	32,1 kg	5,8	o,826	o,59
ROHRER-Index	1,15o	o,119	1,164	o,125	7,453	< o,oo1

Table 2: Correlations between anthropometric parameters and parental income

Boys (n = 197)

Body height / Parental income	r = + o,o66; P = o,61
Body weight / Parental income	r = + o,o13; P = o,86
ROHRER-Index / Parental income	r = - o,o54; P = o,52

Girls (n = 176)

Body height / Parental income	r = + o,oo8; P = o,9o
Body weight / Parental income	r = + o,o58; P = o,58
ROHRER-Index / Parental income	r = + o,o67; P = o,65

Table 3: Correlations between anthropometric parameters and number of sibs

Boys (n = 197)

Body height / Number of sibs	r = - o,o38; P = o,6o
Body weight / Number of sibs	r = - o,o89; P = o,21
ROHRER-Index / Number of sibs	r = - o,o9o; P = o,2o

Girls (n = 176)

Body height / Number of sibs	r = + o,oo3; P = o,97
Body weight / Number of sibs	r = - o,o16; P = o,83
ROHRER-Index / Number of sibs	r = + o,o33; P = o,66

Table 4: Correlations between anthropometric parameters and number of children per household

Boys (n = 197)

Body height / Number of children p.h.	r = - o,o38; P = o,6o
Body weight / Number of children p.h.	r = - o,1o4; P = o,14
ROHRER-Index / Number of children p.h.	r = - o,11o; P = o,12

Girls (n = 176)

Body height / Number of children p.h.	r = - o,o11; P = o,87
body weight / Number of children p.h.	r = - o,o23; P = o,76
ROHRER-Index / Number of children p.h.	r = + o,o23; P = o,76

Table 5: Body height income groups

Income groups	Boys n	Boys $\overline{x}$	Girls n	Girls $\overline{x}$
< 6oo DM	--	--	4	142,5 cm
6oo - 1.ooo "	14	142,4 cm	7	14o,9
1.ooo - 1.5oo "	3o	142,6	25	14o,7
1.5oo - 1.9oo "	36	14o,8	29	138,4
1.9oo - 2.5oo "	45	139,8	44	14o,8
2.5oo - 3.6oo "	49	142,3	41	14o,o
> 3.6oo "	23	142,2	26	141,5
	197	141,5	176	14o,4

Table 6: Body weight and income groups

Income groups	Boys n	Boys $\overline{x}$	Girls n	Girls $\overline{x}$
< 6oo DM	--	--	4	31,3 kg
6oo - 1.ooo "	14	32,1 kg	7	35,o
1.ooo - 1.5oo "	3o	33,1	25	31,5
1.5oo - 1.9oo "	36	33,o	29	31,1
1.9oo - 2,5oo "	45	31,1	44	33,5
2.5oo - 3.6oo "	49	33,1	41	31,5
> 3.6oo "	23	34,9	26	32,2
	197	32,8	176	32,2

Table 7: ROHRER-Index and income groups

Income groups	Boys n	Boys $\overline{X}$	Girls n	Girls $\overline{X}$
< 600 DM	--	--	4	1,091
600 - 1.000 "	14	1,113	7	1,250
1.000 - 1.500 "	30	1,134	25	1,125
1.500 - 1.900 "	36	1,174	29	1,161
1.900 - 2.500 "	45	1,135	44	1,185
2.500 - 3.600 "	49	1,145	41	1,139
> 3.600 "	23	1,181	26	1,140
	197	1,148	176	1,156

slightly with increasing number of sibs. The same is to be seen concerning the number of children per household. These values are, however, also not signifecant. In girls the relations between these anthropometric parameters and number of sibs resp. children per household are obviously still less marked and somewhat controverse. In general one con say referring to the figures given in Tables 3-4, that the numbers of sibs resp. children per household seem to be indeed of some influence on the develepment of height and weight, but, however, to a rather little and statistically insignificant extend only.

In Tables 5 - 7 the total material has been split up into different income groups. For each of these groups the mean of body height, body weight and ROHRER-Index are given. As the individual numbers in the single income group are unfortunately rather low, these groups were combined into the following three:

Low Income	<	DM 1.5oo,-- per month (gross)
Middling Income		DM 1.5oo,-- DM 2.5oo,-- p.m. (gross)
High Income	>	DM 2.5oo,-- per month (gross).

The mean anthropometric values for these three income groups are shown in Figure 1, separated for boys and girls. It is to be seen from these data, that no marked and statistically significant differences are present between the children of different income groups. In particular there is no evidence for a distinct disadvantage in the growth development of children of lower income groups.

The same is to be seen from Tables 8 - 9, in which simultaneously parental income and number of sibs (Table 8) resp. parental income and number of children per household (Table 9) and anthropometric parameters are considered. The correlation coefficients demonstrated in these tables are generally low and statistically not significant. Furthermore, they are somewhat controverse. Thus one can say that on no account any obvious and worth mentioning relations between anthropometric and socioeconomic parameters are present, e.g. of that kind,

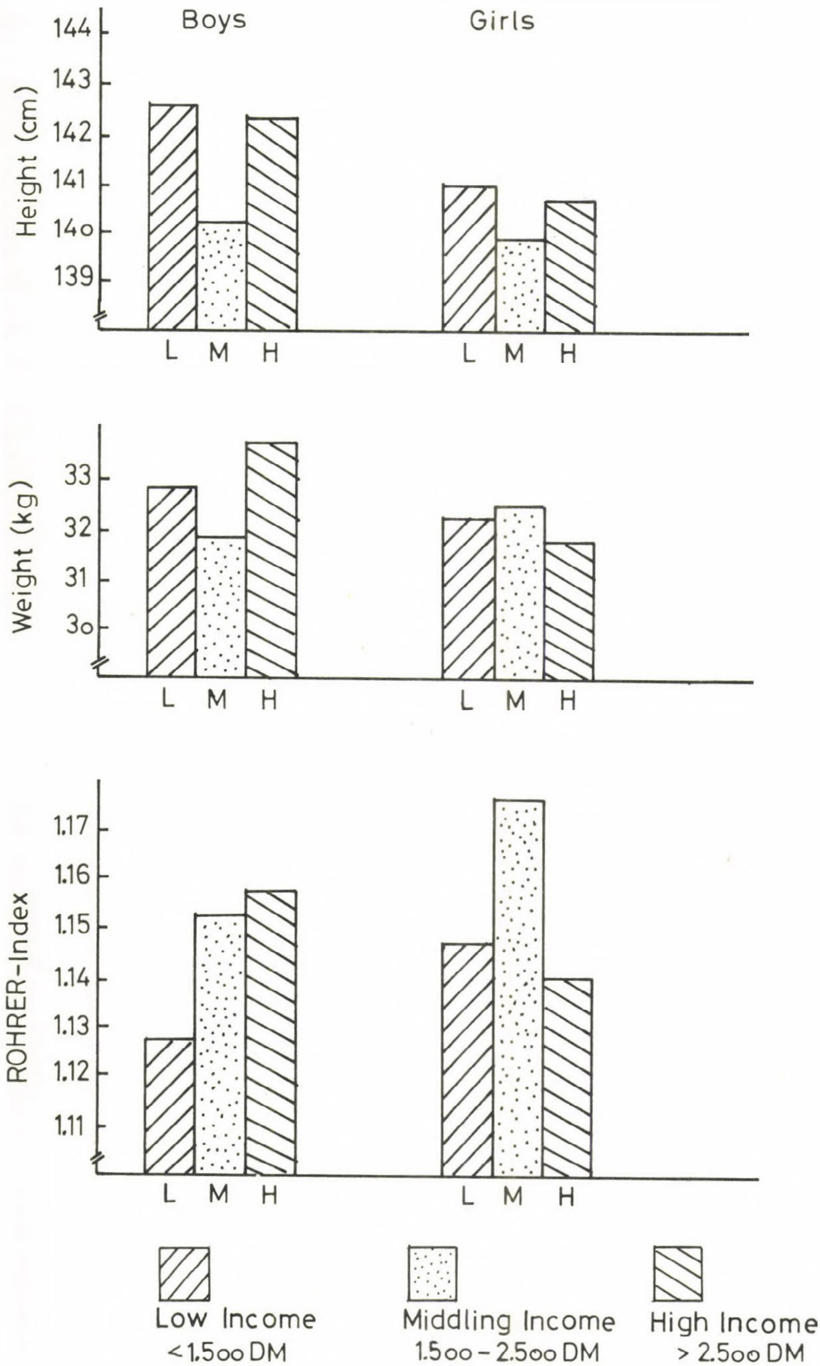

Figure 1: Body height, body weight and ROHRER-Index in different income groups

Table 8: Multiple correlations between parental income, number of sibs and anthropometric parameters

Boys (n = 197)

Income groups	n	Body height	Body weight	ROHRER-Index
< 6oo DM	--	--	--	--
6oo - 1.ooo "	14	r = + o,4oo	r = + o,191	r = - o,244
1.ooo - 1.5oo "	3o	+ o,o7o	- o,216	- o,288
1.5oo - 1.9oo "	36	- o,1oo	- o,o42	+ o,o86
1.9oo - 2.5oo "	45	- o,1o3	- o,273	- o,195
2.5oo - 3.6oo "	49	- o,o57	- o,o4o	- o,o19
> 3.6oo "	23	- o,o3o	+ o,o86	+ o,143

Girls (n = 176)

Income groups	n	Body height	Body weight	ROHRER-Index
< 6oo DM	4	--	--	--
6oo - 1.ooo "	7	r = + o,152	r = + o,625	r = + o,5oo
1.ooo - 1.5oo "	25	- o,o83	+ o,o18	+ o,223
1.5oo - 1.9oo "	29	- o,166	- o,o7o	+ o,171
1.9oo - 2.5oo "	44	- o,183	- o,155	+ o,o23
2.5oo - 3.6oo "	41	+ o,349^{x}	+ o,158	- o,115
> 3.6oo "	26	- o,o8o	- o,113	+ o,o26

^{x} = P ∿ o,o3

Table 9: Multiple correlations between parental income, number of children per household and anthropometric parameters

Boys (n = 197)

Income groups	n	Body height	Body weight	ROHRER-Index
< 6oo DM	--	--	--	--
6oo - 1.ooo "	14	r = + o,231	r = + o,382	r = + o,o77
1.ooo - 1.5oo "	3o	+ o,o76	- o,21o	- o,294
1.5oo - 1.9oo "	36	- o,o45	- o,o24	+ o,o97
1.9oo - 2.5oo "	45	- o,o18	- o,354^{x}	- o,326^{xx}
2.5oo - 3.6oo "	49	+ o,o34	+ o,oo3	- o,o57
> 3.6oo "	23	- o,o6o	+ o,o56	+ o,12o

^{x} = P ∿ o,o2 ^{xx} = P ∿ o,o3

Girls (n = 176)

Income groups	n	Body height	Body weight	ROHRER-Index
< 6oo DM	4	--	--	--
6oo - 1.ooo "	7	r = + o,152	r = + o,625	r = + o,5oo
1.ooo - 1.5oo "	25	+ o,o31	- o,o12	+ o,o34
1.5oo - 1.9oo "	29	- o,2o9	- o,113	+ o,193
1.9oo - 2.5oo "	44	- o,236	- o,245	- o,o76
2.5oo - 3.6oo "	41	+ o,273^{x}	+ o,192	- o,-26
> 3.6oo "	26	+ o,o11	- o,o15	+ o,o72

^{x} = P ∿ o,o8

that in lower income groups the number of sibs resp. the number of children per household would influence the growth development more negative than in the better-off groups.

IV. Discussion

After all we can point out that in this material no obvious relations between socioeconomic factors like parental income, number of sibs resp. number of children per household on the one hand and anthropometric parameters like body height, body weight and ROHRER-Index on the other hand are to be seen. By this our observations in Mainz (WALTER et al. 1975) are confirmed, and also those communicated by other authors working in this field, e.g. LENZ (1959), JÜRGENS (1971) and STRASS (1976).

In this context it should be mentioned, however, that the considerable decrease or even complete disappearance of social differences in the distribution of anthropometric parameters could be observed only in countries with high economic standards like most of the European ones. Against that this phenomenon is not seen in the countries of the so-called "Third World" as it comes out from numerous studies published or cited in SCRIMSHAW et al. (1968). SCRIMSHAW and GORDON (1968), SOMOGYI and KODICEK (1969), GYÖRGY and KLINE (197o), SOMOGYI (197o, 1973) and SOMOGYI and FIDANZA (1972); see also MALHOTRA (1966).

Considering the results of modern growth research one can suppose, that the formerly observed social differences in the distribution of anthropometric parameters were rather caused by exogeneous than by genetic factors. This assumption is not at least supported by the fact, that the so-called acceleration of trowth took place particularly in the lower social groups, against that to an only much lower degree in the upper social groups, which could be observed e.g. in Switzerland (LENZ,1959) and in Germany (STRASS, 1976). The reasons for this and in connection herewith the clear decrease resp. disappearance of the above mentioned social differences are without any doubt to be seen in the radical change of the life conditions of the lower social groups. As compared to the time about the last decades of the 19th century and also to that in the first half of this century the socioeconomic situation of the lower social groups grew without doubt essentially better. Increasing incomes, reduction of number of children per family, improvement of the hygienic conditions as well as the abolition of infant work and many other social alterations effected certainly conditions, which especially were for the benefit of the lower class children and favoured their physical development.

Referring to our data from Bremen one can assume, that even in the lower income groups the preconditions for an optimal physical development nowadays seem to be present. As physical development depends to a great on a sufficient supply with protein (and also caloric) rich food during the postnatal growth period one can conclude finally, that under the present conditions in the lower income groups sampled from Bremen no nutritional deficits are present, which would have lead to demonstrable anthropometric differences in comparison with children out of higher income groups.

It goes without saying that this presumable independence of physical development from the familiar income situation does not implicate just so an income-independence of psychical and particularly educational development. This, however, is not to be discussed here.

Summing up we can point out that in a sample of 1o years old boys and girls from Bremen body height, body weight and ROHRER-Index do not show any remarkable dependences from socioeconomic variables like parental income, number of sibs and number of children per household. These observations are in agreement with those obtained onother European populations. It is supposed that this is to be seen as a result of the considerable improvement in the general life conditions which took place after World War II and which especially favoured the economic situation of the lower social groups and lead to much better conditions for the sphysical development of their children as have been existing ever before. Thus this investigation supports also the assumption that the former social differences in the distribution of anthropometric parameters were rather conditioned by environmental than by genetic factors.

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THE PHYSIQUE OF STUDENTS OF THE TECHNICAL UNIVERSITY, BUDAPEST

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Abstract

First years students of the Technical University, Budapest in 1974/75 were examined. The data show the influence of the socioeconomic factors – place of birth, father's occupation and family size – to affect body development also in our days. The differences are small but the tendency is obvious.

Introduction

The factors determining body development are polyfactorial consisting of genetical /endogenic/ and enviromental /exogenic/ elements. Recent researches /Malhotra 1966, Nemeskéri 197o, Young 197o, Wolański 1973, Kawahata et al. 1975 and others/ indicate that among the exogenic factors especially nutrition more precisely the quantity of consumed protein is decisive in body development.

These data are well supported by the results of other investigations along different lines: acceleration and secular trends. Papers by Bakwin /1964/, Damon /1965, 1974/, Schmidt-Kolmer /1965/, Walter - Fritz - Welker /1975/ and others showed little difference between body measurements of present and earlier children of this century of well-to-do parents in the USA and in Europe furthermore, the previous considerable difference existing between body measurements of rich and poor parents' children gradually decrease. The reason is evident: well-to-do people living one or two generations before could already grant their children the nutrition and other economical factors needed for the optimum physical development, while the same is, available for the poor people only nowadays.

Material and methods

In the Polyclinic of the Technical University, Budapest regular screening tests are made in first and fifth year - to record the health state and the body development of students /Till - Gyenis 1975/. Recent paper has been concerned with the socioeconomic factors influencing the body development of the first-year students of 1974/75. 17 body and head measurements were taken and the constitutional index of Kaup's was calculated in conformity with the instructions of the International Biological Program /Weiner - Lourie 1969/ subsequently the data were processed on a computer ODRA 12o4.

The age of first-year students was between 18 and 26 years, but we have only analyzed in detail the data of the two biggert age groups, i.e. the data of 726 boys of 2o years and 196 girls of 19 years old because in the other age-groups the low incidence rate would have destorted the results of the complex analysis. From the socioeconomic factors influencing body development only the place of birth, father's occupation and number ot children in the family have been examined in this paper. As to birth place distinction was made between students born is Budapest and in the country, the father's profession belonged to three groups: professional, manual and other, while the number of children in the family was simplified as 1,2,3 and more than 3. Let us underline that the students in the Technical University. as in general the university students are a selected group and our results can only be interpreted for them.

Results and Discussion

The average height of boys of 2o is 176,26 cm, their weight is 66,71 kg yielding a value of 2,14 for Kaup's index expressing the physique /table 1/. Comparing our data with those from the mid-thirties /c.f.Nemeskéri 197o/ it be comes evident that young people of today are taller and heavier than those of the previous generation. Thus, acceleration

Table 1

Weight /g/ and height /mm/ measurements and Kaup's index of boys as related to their birth-place

Measurements	Birth-place Mean /N= 726/	Budapest /N= 318/	Country /N= 4o8/
Weight	667o5.6o	67128.1o	66376.2o
Height	1762.6o	1766.91	1759.25
Sitting height	823.77	824.o3	823.57
Shoulder height	1444.6o	1446.31	1443.27
Finger height	644.63	666.44	663.22
Iliac spine height	994.7o	996.76	993.o9
Kaup's index	2.14	2.15	2.14

and secular trend persist further. On the other hand, the low value of the Kaup's index indicates that most boys of today belong to the group of weaker physiques.

The average height of girls of 19 is 164,66 cm, their weight is 55,o2 kg, the value of Kaup's index is 2,o3 /table 2/. Comparing these values with the former ones, the height of girl students shows a very high value, at the same

Table 2

Weight /g/ and height measurements /mm/ and Kaup's index of girls as related to their birth-place

Measurements	Birth-place Mean /N= 196/	Budapest /N= 1o1/	Country /N= 95/
Weight	55o15.3o	55o59.4o	54968.4o
Height	1646.57	165o.26	1642.65
Sitting height	766.72	767.53	765.85
Shoulder height	1344.7o	1344.94	1344.35
Finger height	634.86	634.9o	634.81
Iliac spine height	925.46	925.36	925.58
Kaup's index	2.o3	2.o2	2.o3

time their weight is the lightest, lower even than the girls, of 35 years ago. It has to be borne in mind that before the Second World War workers' children - especially girls - could hardly study at universities in Hungary: it was reserved only for children from well-to-do families. In any case the Kaup's index resulting from these low weights hints to the weak body development of girls.

Concerning the place of birth, weight and measures of length /body height, sitting height, shoulder height, finger height and iliac spine height/ are higher for boys born in Budapest /table 1/. The same is true for the majority of width and circumference values /shoulder and hip width, chest breadth, chest-, upper arm-, thigh- and calf circumference/ - expecting shoulder width and chest breadth /table 3/.

Table 3

Width /mm/ and circumference /mm/ measurements of boys as related to their birth-place

Measurements	Mean /N= 726/	Birth-place Budapest /N= 318/	Country /N= 4o8/
Shoulder width	4o1.86	4o1.74	4o1.95
Chest breadth	295.85	294.97	296.54
Hip width	277.24	277.55	276.99
Chest circumference	9o8.56	91o.54	9o7.o3
Upper arm circumference	266.63	268.66	265.o5
Thigh circumference	534.o2	538.47	53o.56
Calf circumference	362.3o	363.42	361.43

For the girls' weight and length values - excepting iliac spine height - and the width and circumference values save shoulder and hip width - the situation is the same, namely, girls who were born in Budapest have greater body measurements /table 2 and 4/.

Table 4

Width /mm/ and circumference /mm/ measurements of girls as related to their birth-place

Measurements	Mean /N= 196/	Birth-place Budapest /N= lol/	Country /N= 95/
Shoulder width	363.62	363.43	363.83
Chest breadth	262.51	262.58	262.42
Hip width	269.44	268.97	269.95
Chest circumference	854.58	855.54	853.55
Upper arm circumference	241.62	241.63	241.61
Thigh circumference	547.71	548.o7	547.34
Calf circumference	343.14	344.13	342.o9

According to the father's occupation all body measurements of boys of professionals are greater to the children of worker families /table 5 and 6/.

Table 5

Weight /g/ and height /mm/ measurements and Kaup's index of boys as related to fathers' occupation

Measurements	Fathers' occupation Professional /N= 37o/	Manual /N= 251/	Others /N= 1o4/
Weight	66875.oo	66313.3o	67o56.1o
Height	1766.78	1756.31	1762.76
Sitting height	824.54	821.77	825.88
Shoulder height	1448.o9	1439.8o	1443.91
Finger height	668.17	66o.13	662.91
Iliac spine height	995.78	992.74	995.5o
Kaup's index	2.14	2.15	2.15

Table 6

Width /mm/ and circumference /mm/ measurements of boys as related to fathers' occupation

Measurements	Fathers' occupation: Professional /N = 37o/	Manual /N= 251/	Others /N= 1o4/
Shoulder width	4o2.1o	4o1.47	4o1.83
Chest breadth	295.95	295.7o	295.o7
Hip width	276.74	276.8o	28o.21
Chest circumference	9o9.61	9o7.94	9o6.39
Upper arm circumference	268.o2	265.59	264.19
Thigh circumference	536.54	529.56	536.o8
Calf circumference	363.69	36o.41	361.91

The majority of girl body measurements give a similar pattern /table 7 and 8/.

Table 7

Weight /g/ and height measurements /mm/ and Kaup's index of girls as related to fathers' occupation

Measurements	Fathers' occupation: Professional /N= 119/	Manual /N= 61/	Others /N= 16/
Weight	55o96.6o	54o65.6o	58o31.3o
Height	1646.63	1646.o5	1648.13
Sitting height	768.5o	767.o3	752.25
Shoulder height	1342.81	1345.38	1356.25
Finger height	635.44	632.52	639.44
Iliac spine height	923.29	925.44	941.75
Kaup's index	2.o3	1.99	2.14

Table 8

Width /mm/ and circumference /mm/ measurements of girls as related to fathers' occupation

Measurements	Fathers' occupation		
	Professional /N= 119/	Manual /N= 61/	Others /N= 16/
Shoulder width	363.67	363.o8	365.31
Chest breadth	263.46	258.26	271.56
Hip width	267.63	27o.o5	28o.62
Chest circumference	858.12	84o.75	88o.94
Upper arm circumference	242.24	238.56	248.69
Thigh circumference	548.62	542.18	562.o6
Calf circumference	344.oo	34o.93	345.19

The family size, number of children in the family gives interesting information for boys. Boys from families with more than 3 children are the poorest developed as far as weight, width and circumference measurements and Kaup's index are concerned /table 9 and lo/. This tendency is not so unambiguous as for length measurements likely to depend on hereditary factors while weight, circumferential and width values seem to be influenced rather by exogenetic factors.

Table 9

Weight /g/ and height /mm/ measurements and Kaup's index of boys as related to the number of siblings in the family

Measurements	Number of siblings			
	1 /N=2o9/	2 /N=373/	3 /N=1o5/	>3 /N= 39/
Weight	68oo1.2o	6591o.6o	67427.oo	65423.1o
Height	1764.oo	176o.47	1767.18	1763.23
Sitting height	826.89	819.94	831.32	823.38
Shoulder height	1444.34	1443.1o	1448.96	1448.67
Finger height	667.24	663.71	665.29	657.62
Iliac spine height	994.8o	993.86	995.71	999.38
Kaup's index	2.18	2.12	2.15	2.1o

Table lo

Width /mm/ and circumference /mm/ measurements of boys as related to the number of siblings in the family

	Number of siblings			
Measurements	1 /N=2o9/	2 /N=373/	3 /N=lo9/	>3 /N= 39/
Shoulder width	4ol.81	4ol.84	4o2.35	4oo.97
Chest breadth	297.12	294.91	297.33	294.o8
Hip width	277.41	277.68	275.41	276.97
Chest circumference	914.73	9o5.18	9o9.99	9o4.o3
Upper arm circumference	27o.77	264.82	266.66	261.72
Thigh circumference	541.33	53o.25	536.42	524.49
Calf circumference	364.68	36o.82	364.3o	358.31

Considering girls' weight, width and circumferential measurements, they are similar, on the other hand, length measurements, do not indicate such an unambiguous tendency most likely attributable to the lower number of examined persons /table 11 and 12/.

Table 11

Weight /g/ and height /mm/ measurements and Kaup's index of girls as related to the number of siblings in the family

	Number of siblings			
Measurements	1 /N= 61/	2 /N= 97/	3 /N= 27/	>3 /N= 11/
Weight	55163.9o	55216.5o	54611.lo	534o9.lo
Height	1639.57	1656.53	1634.81	1626.45
Sitting height	77o.16	767.55	758.56	76o.36
Shoulder height	1338.o3	1351.73	1332.96	1348.55
Finger height	631.16	639.o5	623.11	647.18
Iliac spine height	917.72	933.88	917.81	913.oo
Kaup's index	2,o5	2.ol	2.o4	2.ol

Table 12

Width /mm/ and circumference /mm/ measurements of girls as related to the number of siblings in the family

Measurements	Number of siblings 1 /N= 61/	2 /N= 97/	3 /N= 27/	> 3 /N= 11/
Shoulder width	364.13	364.1o	364.11	355.36
Chest breadth	261.77	262.81	264.oo	26o.18
Hip width	267.97	268.85	278.22	261.36
Chest circumference	853.84	852.47	867.96	844.36
Upper arm circumference	244.44	24o.56	24o.93	237.o9
Thigh circumference	549.64	547.94	543.85	544.55
Calf circumference	342.77	345.89	336.41	337.55

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THE INFLUENCE OF SOCIAL FACTORS OF THE PHYSICAL DEVELOPMENT OF YOUNG CHILDREN – A CONTRIBUTION TO THE PROBLEMS OF ACCELERATION

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Comprehensive studies were conducted into the physical development of children up to the age of three, and some more specific surveys were undertaken in the context of menarche and menopause deadlines throughout the German Democratic Republic. The period covered was from 1958 to 1960.
The general trend towards acceleration was supported by the results. Certain peculiarities, however, were established by comparing absolute body measures and rates of development of children of different social categories and putting them against data reported in the literature. The generative phase was quite generally found prolonged by earlier onset of the menarche and delayed cessation of the menses.

The above findings prompted the authors to amend the present definition of acceleration by adding to it the social aspect. Hence, the following definition has been suggested:

"Acceleration is an organic process associated with accelerated development, prolongation of the overall phase of development, and expansion of normal human functionality on the basis of existing social conditions, with the latter being correlated to the given enviroment in terms of a biomorphosis of generations."

The authors are fully aware of the problems implied in such interpretation, since the above definition has been derived from results obtained in a new type of social enviroment

which is characterised by full-scale health care in terms of prophylaxis, therapy, and metaphylaxis, in other words, results for which little comparable conditions exist elsewhere.
The authors' intention, in that context, was to stress the following ideas:

1. Enviroment does have effects upon development in childhood. That point was to be made more strongly, that is, in agreement with its actual importance. Its seems to be quite remarkable that the effect of social factors on the human biology as well as on the development and fitness of children and adolescents is hardly denied by anyone, but it hardly happens that a "primary" role is conceded to environmental factors in programmes of medico-scientific studies, theoretical considerations, and interpretation of results.

2. Acceleration is by no means restricted to childhood and adolescence, but it rather is a process ranging from intrauterine condition to advanced age, although activities and appearances are differentiated over time.

3. The point had to be made that so far proposed and generally accepted differences in the physical development between children of the same age but with different social origins do not obtain, but are attributable to and controllable by social conditions.

The same parameters were studied for comparison in a follow-up investigation in 1970/71.
Additional sociological aspects were included, with the view to compiling scientifically planned and selected data through which results of greatest possible accuracy might be achieved.
Yet, some difficulty was faced when optimum assessment of social factors was attempted. Assessment of relevance was problematic for the following reasons:
(a) While the greatest possible effort was made for high-accuracy definition, full delimitation and differentiation of the factors involved proved to be not feasible.

(b) Multifactorial interabtion was generally established, for which reason no selected characteristics could be checked in isolation. Impact and relevance of one factor alone, therefore, could not be elucidated with unambiguity.

The authors, therefore, decided to test larger groups of probands and to limit their conclusions to variables in which at least one parameter had remained to be nearly constant or in which an occurred change was known and thus accessible to judgement.

Comparison, consequently, had to be made on the basis of social groups already established and adopted for the study or with references to earlier accepted regional dimensions, that is, by blue-collar and white-collar workers and intellectuals or by small villages, big cities and other reference units in between. Before the results will be given in greater detail, a general account of developments is given for better background assessment.

Body measures of children have continued to grow in the past ten years. That appears to suggest that the children population as a whole has enjoyed favourable conditions of life by which primordial growth potentials were further activated.

In the period under review, the body length at birth went up by 0,2 cm in boys and 0,3 cm in girls. These values were not significant and, therefore, should be interpreted rather in terms of continuing compensation for earlier social differences.

Birth weight went up by the order of 100 g, but only in girls. These results were calculated from a population of 49,334 males and 45,843 females, with due consideration having been given to social parameters, as well.

The time that had elapsed between the comparative surveys as well as the population sizes involved supported the conclusion that acceleration has been increasingly influenced by biologically determindes processes, where as the physiology of development proper has remained unchanged.

That seems to suggest with high safety that the rate of

complicated deliveries is not aggravated by disproportionality between newborn measures at birth, on the one hand, and pelvic dimensions of the parturient, on the other.
However, the increase of 0,7 cm for boys and girls towards the age of three in the course of ten years is significant.

Development at large during the first three years of age was checked against the background of the two studies by calculating the percentual increase per age group related to the birth value. All values, generally, went up towards the end of each year of age, indicating change in the rate of development.

Among the probands of 1970/71 the highest percentual rises were established from boys between birth and nine months old as well as from girls between birth and twelve months of age. Beyond those limits, the percentual rises of variables in either group were below those recorded 1958/60. The rate of development also declined more rapidly. Nevertheless, genuine positive development was statistically secured at the end of the third year of age, as may be seen from Tables 1 and 2.

Acceleration in the context of intra-uterine development actually has been "inhibited", with the immediate result of intensified extra-uterine development. However, since the average rate of development between birth and the age of three years was lower than the respective figures had been in 1958/60, the absolute rise of measured variables must be attributed primarily to stronger acceleration within the first year of age.
By considering all results with reference to all social variables involved, one, basically, will find that acceleration continues to be effective.

At the same time, it may be clearly seen that today acceleration acts primarily, and to an increases extent in the above age groups, as some sort of compensation for earlier socially caused differences or development gaps.

The authors feel that in this country a voluminous parcel of political and social measures have strongly contributed to

Table 1

Percentual increase in body length per annum (related to length at birth) 1958/60 and 1970/71

	6th month 1958/60	6th month 1970/71	12th month 1958/60	12th month 1970/71
Boys 0 - 3 years	31.0	32.8	14.3	13.0
Girls 0 - 3 years	30.6	31.3	14.2	14.6
	24th month 1958/60	**24th month 1970/71**	**36th month 1958/60**	**36th month 1970/71**
Boys 0 - 3 years	19.6	20.1	15.8	15.5
Girls 0 - 3 years	20.6	20.0	16.3	15.8

Table 2

Percentual increase in weight per annum (related to weight at birth) 1958/60 and 1970/71

	6th month 1958/60	6th month 1970/71	12th month 1958/60	12th month 1970/71
Boys 0 - 3 years	136	135	66	71
Girls 0 - 3 years	128	131	66	62
	24th month 1958/60	**24th month 1970/71**	**36th month 1958/60**	**36th month 1970/71**
Boys 0 - 3 years	69	55	55	56
Girls 0 - 3 years	71	67	60	60

achieving such situation. Reference should be made, in this context, to improvement of social security, more cash subsidies during pregnancy, at birth, and during maternity leave, legally guaranteed jobs for pregnant women and mothers, free medical care and treatment of mothers and children, as well as higher standards of all medical services.

The effectiveness of the above prerequisites, however, should not be overestimated. It is likely to decline to the extent to which the ratio is changed between child care and child education. While care can be successful on the basis of the above conditions, education requires additionally full utilisation of the parents' knowledge and skills, and these, in turn, depend strongly on the parents' own educational background.

In an effort to arrive at more valid and conclusive assessment, comparisons were made, first of all, between the specific group values exhibited by children of unskilled and skilled labour, white-collar workers, and intellectuals, on the one hand, and the percentual structure recordable from the normal distribution, on the other.

Children in the group of skilled labour, white-collar workers and intellectuals differed from one another merely by slight variation, close to the 50-per-cent point, with a somewhat pronounced trend towards the 75-per-cent point, that is, as shift to the right.

A left-shilft trend, towards the 25-per-cent point, was recordable from children of unskilled workers. That result was clear-cut and independent from the children's assignment to the vocational position of father or mother.

Significant differences of the past for children in the skilled labour group have been completely levelled out over time in the period under review. Higher average rates of development or more pronounced acceleration within shorter time spans have been instrumental to the advent of a situation in which these children do even display the highest values, at least for some measuring points.

Positive developments in terms of progress have been recordable as well from children of unskilled labour. Differences between them and the control groups were no longer significant in all age groups.

This fact together with the indicated or ongoing right-shift of values, particularly in the period of the highest rates of extra-uterine development, appear to support the expectation that further adaptation in this social group may lead to complete equilibrium in the forthcoming years.

The authors also studied developmental processes on the basis of locality sizes as given in the Statistical Year-Book of the GDR. (Index numbers for locality sizes: 1 - below 2,000 inhabitants, 2 - 2,000 to 5,000, 3 - 5,000 to 20,000, 4 - 20,000 to 100,000, 5 - above 100,000)

No unambiguous information has been obtained regarding balances between the above regional categories. The absolute differences actually recorded were sometimes significant and sometimes not, and no explanation was found for such variation. The same pattern had been recorded from the social categories in 1958/60.

By projecting the changes of that group to those of the locality sizes one will find that the absolute differences regarding the various age groups indicate first symptoms of beginning equilibrium, however, with differentiated valence.

Locality size 5 seems to be an exception (big city), with the effects of the essential factors being different in terms of quantity and quality due to differentiated concentration of research and industrial activities, deviating housing conditions, certain peculiarities in way of life, and survical of more barriers between social groups.

The big city, therefore, still differs from all other locality levels, but certain differences have been recorded between big cities, as well.

Consideration was given also to different social groups within one and the same locality size, and the findings were

Table 3

Values /S/ of differences in body length of boys and girls after age, social groups and size of settlement, 1970/71

B o y s

Sozial relation of fathers	Birth					6 months					12 months					24 months					36 months				
size of settlement	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Intellectual - Unskilled worker	-	$+_1$	+	-	+	-	-	-	-	-	-	-	-	+	-	-	-	+	+	+	+	-	-	-	+
Intellectual - Skilled worker	-	$+_1$	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	+	+	-	+	+	-	-	-
Intellectual - Employee	$+^1$	-	+	$+_1$	+	-	-	-	-	+	+	-	-	-	-	-	-	+	+	+	+	-	+	-	-

G i r l s

	Birth					6 months					12 months					24 months					36 months				
size of settlement	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Intellectual - Unskilled worker	$+_1$	-	-	-	-	+	-	$+_1$	+	-	-	-	-	-	-	+	+	+	+	-	+	-	+	-	+
Intellectual - Skilled worker	$+_1$	-	-	+	+	-	-	$+_1$	-	-	-	$+_1$	+	-	$+_1$	-	-	-	+	+	-	+	+	-	-
Intellectual - Employee	-	+	-	-	$+_1$	-	$+_1$	-	-	-	+	-	-	-	$+_1$	-	-	+	+	-	-	-	+	+	-

correlated. Statistically secured deviations were found to exist between body measures of those children along with growing age, as may be seen from Table 3.

This has been interpreted as an indicator to the growing importance of the social groups, as characterised primarily by the parents' educational standards. That importance was found to grow along with growing concentration on education in the care-education ratio.

Yet, findings so far obtained from surveys in the past and resulting prognostication of trends as well as the standards of school education so far achieved seems to justify the expectation that the differences between both social groups and regions or localities can be levelled. Developments so far have shown that such forecasts will not come true unless certain conditions are ensured: Good health care and guaranteed social security for the family must be supplemented by adequate school education for all children and, consequently, general increase of educational standards of the general public.

Social differences between groups have gradually but steadily declined to the extent to which the above concept has been implemented.

In evaluating their results the authors have for the first time given some attention to another problem which will be mentioned but without closer details, because there is no comparability, for the time being.

The relationship between physical work and brain stress has undergone change along with growing industrialisation and technological progress on the shop-floor, and the boundaries between those two forms of work load have become floating. The probands, therefore, were subdivided by primarily physical or intellectual vocational stress on the parents. Certain differences cropped up - in line with expectation.

The results were further analysed with reference to the parents' grades and educational backgrounds.

The occupation actually practised by the parents was found to be more important, as a determining factor, than the trades learnt by them, and just as important was the real standard of education they had achieved.

The same results were combined with findings recorded from other studies in which education had been correlated with the given housing standards, the number of books in a family library, joint leisure activities with the whole family involved, and meaningful as well as sufficient active communication between parents and their children. The conclusion was that all social parameters which were to be used for assessment of development had to be specifically adjusted to the scope of the study, in full agreement with the theoretical hypothesis.

Further studies into acceleration, consequently, will depend not only on the availability of accurate measurement methods for development, but also on the introduction of a sociological typology.

Such typology should be well defined with regard to the radius of action of each of the parameters involved. New findings will not be achievable unless a differentiated assessment is made of acceleration processes in those countries in which the active trend towards developmental changes has been widely completed.

The following summary may be proposed against the background of latest knowledge:

1. Acceleration goes on, but the intensity of developmental changes has been declining in recent years.

2. Body measures which used to be different on account of social factors have become more equal within the last ten years in direct dependence on better health and social services for children and substantive improvement of living standards for the general public.

3. More importance is being attributable to the influence of social factors upon development.

4. Acceleration is a process within the limits of physiology. This process and its results are strongly exposed to biological and social factors.

5. Evidence has been produced to the definition of acceleration as a socially caused modification of human biology.

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ACCELERATED GROWTH AND ITS LONG RANGE CONSEQUENCES

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Introduction

Living organisms have sometimes been called improbable systems. (Young, 1971) This is not because they circumvent or violate the physical laws which govern all matter. Rather, the maintenance of each organism is expensive in terms of energy input. In consequence of the high cost of sustaining the organization which is the essence of life, each organism must be capable of a constant exchange of elements with its environment just to fuel the processes essential to survival.

The demands of the growing organism are both greater and more urgent than those of a mature one. This is so because the system must not only be sustained, but must also be expanded. All the while, homeostasis must be maintained, even though the diversion of nutrients into the process of growth may occur simultaneously with a high metabolic rate and/or high levels of physical activity. The period of growth and development then is a time when the living system demands the most from its environment and is most vulnerable to damage if its demands go unsatisfied.

Early Growth of Humans

A human baby is no exception. Although its mother provides a well-buffered environment for the early stages of growth, the embryo, the fetus and newborn are peculiarly vulnerable to severe stress or deprivation. The intrauterine environment is not totally impervious to changes in the environment experienced by the mother. There are limits for instance, to the extent that a malnourished mother can sustain fetal growth through the depletion of her own tissues. The limit is subject to considerable individual variation. Thus, the degree to which it is accurate to describe the developing fetus as a "perfect parasite" remains a matter of controversy (Winick, 1976).

While there is no significant correlation between maternal stature and birth weight in affluent societies, there is a direct correlation linking the two variables in populations where food is less abundant. Such correlations are a good indication that where nutrient intake approaches a level too low to permit the maternal organism to compensate, fetal growth is retarded. Even in more affluent populations, the weight of the newborn can be shown to increase in proportion to the weight gain of the mother during pregnancy. Although the relationship breaks down at upper and lower extremes it is generally true that the more a mother gains during pregnancy, the heavier her baby will be at birth. Realization of this relationship has led to a recommendation by the National Academy of Sciences that a minimum weight gain of 25 pounds (11.5 kg) be achieved during pregnancy (Wurtman, 1972). This is in sharp contrast to the recommendations made two or three decades ago which usually favored minimal or no weight gain during pregnancy. It does not appear that size at birth bears any significant relationship to adult body size. This implies that postnatal factors have the greatest influence on the size ultimately attained.

Rates of Growth

In terms of both relative and absolute increase in stature, a human being never grows faster than during the fourth fetal month. For a brief period then the velocity of increase attains the remarkable value of 10cm/month. The rate of increase then slackens to a low of approximately 2cm/month just before birth. It is a peculiarity of the human growth curve that the rate of statural increase exhibits another brief interval of acceleration shortly after birth. During this period, the rate of increase is about 4cm/month, a rate which soon gives way to a more modest 6cm/year or thereabouts. During the adolescent growth spurt, growth may again occur at the rate of 1cm/month for a short time.

In most respects, weight increase parallels that occurring in stature. However, weight is far more variable at birth and throughout life, reflecting as it does fluctuations in a number of body components. An obvious but significant fact is that increases in weight are to varying degrees reversible. This is not true of statural growth.

The Role of Environment

While body size and the patterns of growth which achieve it are under genetic control, the size attained also reflects environmental conditions. Secular increases in body size throughout the world give convincing evidence that improved environmental circumstances permit the attainment of larger body size in populations of a variety of genetic backgrounds. Improvements in medical care and public health programs certainly have had a role in this widespread increase. But it seems quite clear that the most important single factor has been a general increase in both caloric and protein intake in the populations involved. It should be kept in mind however, that although generally improved health status prevails in the same populations which have exhibited increases in body size, it does not necessarily follow that increased body size is conducive to better health. A reduction in the frequency and severity of infectious diseases experienced during crucial periods of growth removes an important constraint on the growth process. Still, there are too many confounding variables involved to permit the assertion that larger body size is a reliable predictor that an individual will enjoy good health or great longevity. Whether larger body size is or is not conducive to improved health and longevity is certainly not a trivial question. But it is a hard one to answer. Moreover, it is a question which may easily lead to misinterpretation, with the risk that it will be seen as an attempt to undermine efforts to improve the health status of currently-undernourished populations. This is unfortunate since realization of disadvantages of excessive growth in more affluent populations could become an inducement to a more equitable distribution of the world's food resources in the future.

Effects of Reduced Food Intake on Growth

Damage occurring early in the development of an organism tends to produce severe aftereffects. In most instances serious trauma in early embryonic life will terminate pregnancy. Such early embryonic deaths often go unrecorded, but probably make up the majority of prenatal mortalities. Later in embryonic life and throughout the fetal period, damage to the developing organism may produce permanent abnormalities instead of death.

The severity of the damage induced in utero depends upon the type of growth occurring at the time. (Altman, et al 1970)

The early stages of growth involve rapid cell division. During this, the hyperplastic phase of embryonic life, the amount of DNA and the mass of protein present increase proportionately. It is also during this time, that organs are forming. It is therefore a time of vulnerability to damage. Significantly, the level of RNA which will prevail at maturity is reached early in the growth process. Substantial quantities of RNA are a sure sign of active protein synthesis (Winick, 1976). The most pronounced increase in the ratio of RNA to DNA at this time occurs in skeletal muscle, the heart and salivary glands.

During the next phase of intrauterine growth, increases in both cell number and cell size occur. During this phase of growth both the total amount of DNA and that of protein increase. But, protein synthesis outstrips DNA synthesis leading to a rise of the protein/DNA ratio.

Finally, increase of cell size rather than number becomes the chief component of growth, producing a steady increase in protein content while DNA and RNA levels remain stable. This, the phase of hypertrophic growth, spans the entire third trimester of pregnancy and continues into the postpartum period.

An exception to the above-described sequence is seen in organs important to the immune systems. For instance, in both the thymus and the spleen, growth continues by cell division and not cell size. As a result, these lymphatic organs maintain a constant ratio of protein to DNA.

The liver, active in protein synthesis throughout life has a predictably high proportion of RNA. Its RNA/DNA ratio is higher and somewhat more variable than that of other tissues. It has also been shown (Winick, 1976) that the RNA/DNA ratio in liver rises during the neonatal period when a rapid increase in enzyme production takes place.

Nutrition and Growth

The developing fetus is especially subject to damage during the time when growth involves a large hyperplastic component. For most tissues, this means that the fetus runs the risk of serious injury if deprived of sufficient nutrients right up to the third trimester. Even during the later stages of gestation, certain organs, among them the liver, thymus and spleen remain vulnerable. But these tissues, which experience cell turnover well into postnatal life also have great recuperative powers.

In view of the considerable vulnerability of the developing organism it is hardly surprising that we, along with other mammalian species have evolved an elaborate buffering system to protect it. This system can, when necessary function through the depletion of maternal tissue reserves to maintain the fetus during times of nutritional inadequacy. This buffering system also has distinct limitations. The observed reduction in birth weights of babies of undernourished mothers is evidence of such limitation. The high mortality rate of undersize infants is an indirect measure of the selective value of a successful maternal buffering system.

The early phases of development and growth are a time when the demands of the organism are urgent and essentially inflexible. Moreover, an upper limit on fetal size is imposed by placental diffusing capacity and the size of the birth canal. Therefore, the range of variation on the size of surviving neonates is restricted. The mean weight in well-fed populations is about 3200g. while a birthweight less than 2500g has been classified "premature" although the implication of a shortened gestational period is sometimes misleading.

Infants of under 2500g birthweight may be undersize for reasons other than prematurity. Some infants are small for gestational age because of intrinsic growth failure, usually associated with genetic defects. In most cases, such infants have normal placentae.

Failure of placental growth sufficient to supply the demands of the growing fetus may produce undersize infants due to what Winick calls extrinsic factors. In his classification Winick identifies infants whose growth was deranged by insufficient supply of maternal blood to the diffusing surface of the placental membrane. Under such conditions some tissues are affected more than others. The liver is severely reduced in both size and glycogen content while the brain is normal. This is the form of fetal growth arrest most encountered in developed countries where maternal nutrition is usually adequate.

In developing countries and in the less affluent segment of developed ones a more symmetrical reduction in size is generally seen. This is most often caused by maternal malnutrition. It has been shown that supplementation of the maternal diet can raise average birth weights in undernourished populations by 300g or more.

The maternal buffering system is such that caloric supplementation can occur early or late in pregnancy and still produce the desired effect. Moreover, supplementation need not be in the form of high grade protein in order to be effective. Except in areas where long-term protein deficiency is the primary nutritional problem, caloric supplementation of the maternal diet which permits mobilization of maternal protein reserves, allows continued growth of the fetus. McLaren (1974) has argued convincingly that considerable waste and even harm has resulted from the mistaken belief that malnutrition in developing countries is inevitably linked to an inadequate supply of protein. Since caloric supplementation is possible in many cases where additional protein is unavailable, it is important to identify those situations where the more-abundant carbohydrate foods may be used to good advantage. As McLaren points out, increasing protein intake in the form of powdered milk may prove downright detrimental in populations where lactoss intolerance is widespread. It is also possible that many, perhaps most, of the world's populations would not benefit from the levels of protein intake frequently recommended. In fact, the maximization of growth associated with high protein intake must not necessarily be regarded as optimal in terms of general health and/or longevity. Here lies a matter of urgent global concern.

Growth and Longevity

While it is quite true that increasing average life span has paralleled increased average body size in the industrialized nations, there is no convincing evidence that the former has not occurred in spite of rather than because of the latter. The possibility that smaller body size would confer benefits in the form of improved health and longevity can no longer be rejected out of hand. In populations where very little is gained by increased size and muscular development it is not surprising that the individuals who survive past the tenth decade of life tend to be below average in weight and stature. Small average body size also characterizes populations for which claims of unusually great longevity are most often made. While it is often possible to dispute the ages claimed in areas where records are scanty, it appears that the people involved are truly of advanced age.

What factors might link small body size and increased longevity? An obvious one is dietary intake. But the relationship is not one of simple cause and effect. For instance, cancer of the breast and colon are more prevalent in well-nourished than in undernourished human populations. (Wynder and Mabuchi, 1972) Both weight and height have been shown to be positively correlated with the incidence of cancer in postmenopausal women (DeWaard and Baanders-VanHalewijn, 1974). The implication of increased estrogen synthesis and possible storage in adipose tissue of persons consuming fat-rich diets has been suggested (Wynder, 1968). Animal experiments going all the way back to those of McKay in 1935 give evidence that a diet high in protein is associated with reduced longevity in rats. Recent work in a number of laboratories has produced evidence that alterations in the sequence of development of the immune system by early nutritional deprivation may have the beneficial effect of keeping the immune system "young" longer, providing a degree of protection against neoplastic growth later in life. (See, Walford, Liu and Gerbase-Delema, 1973/74; Jose, Stutman and Good, 1973, Ross and Bras, 1971 and Jose and Good 1973).

Autoimmunity, the tendency of the aging immune system to cause damage to ones own tissues may be implicated in the etiology of cancer (Makinodan, 1976). There is evidence that nutritional deprivation early in life reduces the tendency toward autoimmune activity later. Necessarily, most of the evidence drawn upon in this area of research has been obtained through animal experiments and hasty extrapolation to humans would be unwise. But whatever the mechanisms involved, longevity seems to improve when food intake is restricted. Recent experiments with male rats have shown a highly significant ($p < 0.01$) increase in life span when access to food was limited to six hours per day. Moreover, the occurrence of neoplasms was low even though the underfed animals were living to a more advanced age (Drori and Folman, 1976).

<u>Size and Energy Requirements</u>

Human energy requirements are nowhere near as well known as the dissemination of standard recommended allowances would lead one to believe. Individuals perform at a wide range of efficiencies both in terms of energy and protein requirements per unit of work performed. There are numerous ways in which the amount of ATP produced by the breakdown of a given quantity of food can vary (For discussion, see Hegsted, 1974). Early nutritional regime has a profound influence on subsequent nutritional needs. The size of the organism, the result of its previous nutritional intake will, at critical stages in development, determine its future appetite. (Widdowson and McCance, 1975) Thus, a resetting of future nutritional demand occurs in response to what has gone before. Within limits, each individual bears the potential to demand more or less nutrient intake to support its daily activities.

What advantages are gained by larger body size? Under prevailing circumstances there are few indeed. Frisancho and Velasquez (1975) have noted that small body size is a part of high altitude adaptation. Exercise experiments have produced evidence that smaller individuals are functionally more efficient. (For one such study, see Pařízkova and Merhaustova, 1970) Moreover, larger body size inevitably increased energy cost of all work performed. (Stini, 1975) Some notion of the magnitude of widespread increases in human biomass associated with high protein diets can be gotten from the comparison of U.S. and Mexican populations made by Lasker and Womack (1975). The aggregate demand on the world's limited food resources that has resulted from recent increases in average biomass considerably exacerbates the problems arising from population increases.

Growth and Cancer

A recent review in the Dairy Council Digest states: "Of all dietary modifications studied, caloric restriction has had the most regular influence on the genesis of neoplasms in experimental animals".......

Body weight is related to tumor risk. Within each group of animals receiving identical diets, the incidence of every tumor type was consistently greater in heavy rats than in lean rats".

It appears that caloric restriction may inhibit tumor formation through inhibition of mitotic activity. (Tannenbaum, 1959, Kraybill, 1963) Drori and Folman (1976) have shown a clear correlation between restricted feeding, increased longevity and lower incidence of tumors in rats. They interpret their results as indicating the value of higher spontaneous activity levels maintained by the animals on restricted diets. Their results are consistent with those of Ross and Bras (1971). A number of types of cancer in humans seem to indicate a similar relationship. (Wynder and Mabuchi, 1972; Shils, 1973, DeWaard and Baanders-VanHalewyn, 1974; DeWaard, 1975)

Japanese migrants to Hawaii have experienced rapid increase in body size paralleled by increased incidence of cancer of the bowel. Haenszel, et al (1973) argue that increased beef consumption is implicated. They cite as support for their argument the observation that no population with high beef consumption has low incidence of cancer of the bowel. Howell, (1975) also cites a high correlation between beef consumption and bowel cancer. Wynder and Reddy (1975) attribute this correlation to an overall increase in fat consumption. Berg et al (1973) had observed a significant positive correlation between standardized mortality rates for intestinal cancer and national levels of animal protein intake. The countries involved are also characterized by general increases in body size, particularly in recent years.

Summary and Conclusions

Human growth and energy requirements are subject to considerable environmental alteration. In the early stages, trauma and deprivation cause the greatest damage. Maternal buffering usually protects embryonic and fetal development during the most vulnerable phases. However, severe deprivation of the mother will restrict fetal growth and result in smaller, less viable neonates. Maternal BMR and body weight rise during pregnancy. It has been estimated that a pregnancy requires a full allowance of 300k cal/day in extra energy. This amounts to 80000 k cal during the 38 week period. (Blackburn and Calloway, 1976a,b) Lactation costs about 675k cal per day.

Records from the Dutch famine of 1944-45 (Ravelli, Stein and Susser, 1976) lend statistical support to the claim that severe maternal undernutrition produces retarded fetal growth and excessive neonatal mortalities. Famine exposure during the last trimester of pregnancy and the first months of postnatal life produced lower obesity rates in subsequent years. Ravelli et al interpret this to mean that such nutritional deprivation affected a critical period of development for adipose tissue. When deprivation occurred during the first half of pregnancy, the surviving infants showed significantly higher obesity rates. This is interpreted by these investigators as evidence that nutrition of deprivation affects differentiation of hypothalamic centers which regulate both growth and food intake.

From what is known about human growth in its earliest phases, it is clear that the intrauterine and early neonatal periods are a time when essential growth processes require sustained availability of both calories and amino acids. The mother is the source of both. Maternal malnutrition severe enough to interfere with lactation will deprive the newborn of the quality and quantity of nutrition it requires. Nutritional supplementation under such circumstances should ideally replicate the plane of nutrition our species has evolved. Unfortunately, it seldom does. As a result, critical phases of postnatal growth often occur while the nutrient intake is severely unbalanced. The potential for permanent damage to systems undergoing the greatest change, including the rapidly developing brain, should be clear. However, early termination of nursing is not always the result of maternal undernutrition. Nor is the harm done always a result of unavailability of essential nutrients.

In many parts of the world, the prevailing practice is to substitute bottle feeding for nursing soon after birth. Both in terms of quantity and composition the nutritional intake of many newborns differs drastically from the one our species evolved. In affluent societies, the quantity is unlimited and the quality is the "best", i.e. high protein and high fat. This pattern has been adopted in many less affluent areas as well. The result is frequently an artificial acceleration of growth and an early resetting of the infant's need and appetite for food. Continual abundance of food guarantees maximization of growth for most individuals. This is often accompanied by an early accumulation of fat. For instance, children in the U.S. have development of muscle similar to age-matched children in Guatemala (Martorell et al, 1976) and New Guinea (Ferro-Luzzi et al, 1976) but have significantly more fat. Accelerated growth and fat accumulation are associated with earlier sexual maturation. Therefore, not only is much of the current human population tending toward greater individual nutritional demand, but it is also increasing its reproductive potential through a lowering of the age at which reproduction may begin. If current trends continue, the potential increase in human biomass is enormous. If dietary factors associated with increased body size also predispose certain individuals to health problems, a real possibility in view of the preceding discussion, there is additional reason to question the desirability of nutritional patterns which accelerate human growth without producing any discernible functional advantage.

This is not, however, a rationale for neglecting the need to raise nutritional standards in areas where undernutrition is endemic. In view of the factors previously mentioned, the greatest benefit could be gotten by assuring adequate nutrition of pregnant and lactating women. Nursing should be emphasized (Sosa, 1976). The benefits would be not only in terms of continued normal growth and development but in enhanced cell-mediated immunity to infection. (Neumann et al, 1975) It might thus be possible to increase the proportion of the population who are healthier even though not larger instead of using scarce resources to increase size without necessarily improving health.

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SECULAR GROWTH TREND DATA IN BELGIAN POPULATIONS SINCE 1840 – A DIMENSIONAL AND PROPORTIONAL ANALYSIS

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ABSTRACT

A proportional comparison of weight values from Belgian secular trend data (using 5 reported studies from 1840-1967/71), according to the unisex phantom developed by Ross and Wilson (1974) was made. An analysis of the results indicated that z scores for the present day boys and girls were lower at ages 6,7,8 and 9 than those of the children of 1840. At ages 10,11 and 12 the z scores were more similar for boys and girls of these two time periods except for the 1840 boys. The tendency is that the modern children tend to be leaner at an earlier age than children of former years.

Using the same data a dimensional analysis was made to determine the relationship between body weight (w) and body height (h). A double logarithmic regression equation was used where the exponential value in the equation $w=kh^e$ is determined. Exponential values over the age ranges 6-12, 6-11, 6-10, 6-9, 6-8, and then 6-7, 7-8, 8-9, 9-10, 10-11, 11-12 were calculated, the latter group expressing dimensional velocities. It is shown that the exponential values of height and weight measurements, taken previously to the latest study, were lower than those for the modern day children.

INTRODUCTION

In 1840 the well known Belgian physical anthropologist, Quetelet (1842) carried out a large cross-sectional survey of Belgian children, producing the first set of norms which were used clinically for over seventy years in Europe. Subsequent to Quetelet's surveys there have been four majer cross-sectional studies in Belgium which include mean height and weight values as summarized in Table I.

Secular trend data is classically looked upon in absolute terms as discussed by Tanner (1964), Van Wieringen (1972) and corroborated studies elsewhere ; there is an apparent universal secular trend for both increased stature and body weight. The mean values for boys and girls from the Belgian studies show this clearly with nearly all reported mean values in every study since 1840 being larger than previously stated values at each age level as shown in Table II.

Since the development of the phantom or unisex human prototype by Ross and Wilson (1974) it is now possible to proportionally analyze anthropometric data in terms of a human standard. Vajda et al. (1974) showed that boys measured in 1840 at ages 6,7,8 and 9 were proportionally heavier for their height than the boys in subsequent studies and at ages 10,11 and 12 they became proportionally lighter than the modern boys as shown in Table III. The girls measured in 1840 were not always heavier than the girls of 1924, 1929/30 and 1960 at ages 6,7,8,9,10,11 and 12, but always heavier than the girls measured in the most recent Performance and Talent Study (Hebbelinck and Borms 1975).
Furthermore the six year old is always heavier for his height as compared to the twelve year old and the girls who are lighter at age six approach male values by age twelve in 1924, 1929/30 and 1960, but in 1840 and 1970 the boys were proportionally lighter.

Consideration of secular trend data in dimensional terms as discussed by Åstrand and Rodahl (1972), and Hebbelinck and Ross (1974), may reveal information about the status of growth over the years.
The purpose of this paper is to investigate the dimensional relationship between height and weight for the Belgian secular data and compare the results to phantom z scores.

TABLE I

Cross-sectional studies of Belgian children

AB 1840	QUETELET, M.A. -	A treatise on man and the development of his faculties, Edinburgh, 1842, N = ?
1924	MINISTRY OF ART AND SCIENCE, COMMITTEE FOR RELIEF OF BELGIUM,	Hoover Commission. N = 18.000
1929/30	MINISTRY OF PUBLIC AFFAIRS AND EDUCATION	N = 17.000
1960	MINISTRY OF HEALTH AND WELFARE	N = 55.000 boys, N = 45.000 girls
1967/68	PERFORMANCE AND TALENT PROJECT	N = 7.500 boys (Netherlandish and French speaking)
1971	PERFORMANCE AND TALENT PROJECT	N = 5.500 girls (Netherlandish speaking)

TABLE II

HEIGHT AND WEIGHT OF BELGIAN BOYS AND GIRLS FROM 1840 UNTIL 1971.

YEARS	SEX	AB 1840 Ht(cm)	Wt(kg)	1924		1929/30		1960		1967/68 M 1971 F	
6	M	104.7	17.2	109.7	18.4	110.3	19.6	114.0	20.5	116.3	20.9
	F	103.1	16.0	109.2	18.1	109.5	19.1	113.5	19.5	116.7	20.5
7	M	110.5	19.1	115.0	20.3	116.3	21.5	119.5	22.5	121.3	23.0
	F	108.6	17.5	114.7	19.9	115.3	20.8	118.8	21.5	120.9	22.2
8	M	116.2	20.8	120.5	22.4	120.9	23.2	125.5	25.0	127.0	25.6
	F	114.1	19.1	119.9	21.7	120.5	22.6	123.5	24.0	126.6	24.6
9	M	121.9	22.7	124.8	24.3	126.3	25.0	130.0	27.5	132.0	28.2
	F	119.5	21.4	124.5	23.8	126.1	24.8	129.0	27.0	131.7	27.1
10	M	127.5	24.5	129.5	26.4	130.2	27.6	135.0	30.0	136.8	31.0
	F	124.8	23.3	130.4	26.5	130.1	26.9	134.0	30.0	136.6	29.9
11	M	133.0	27.1	134.1	28.8	134.8	29.5	140.0	33.0	141.4	33.8
	F	129.9	25.7	134.8	29.0	135.3	29.7	139.5	34.0	142.7	33.9
12	M	138.5	29.8	138.2	31.2	139.4	32.9	144.5	37.0	145.5	36.6
	F	135.3	29.8	140.0	32.2	141.5	34.5	146.0	38.5	147.6	37.3
13	M	143.9	34.4	143.0	34.0	143.8	35.7	149.5	41.0	149.1	39.7
	F	140.3	32.9	145.8	36.2	147.2	38.2	151.5	43.5	150.6	41.4

Note : 1971 girls data from flemish sample only

MATERIAL and METHOD

The dimensional model is based on the general reasoning that all body length, breadths, girths, skinfold thickness and times have the dimension L, areas such as body surface and cross section of muscles, L^2 and weights and volumes, L^3. Given that it shape and composition are constant then theoretically if height is used as the criterion for size, weight would became dimensionless when it is proportional to h^3.

Expenential values for the mean height and weight values shown in Table II were calculated over the age ranges 6 to 13, 6 to 11, 6 to 10, 6 to 9, 6 to 8 and then 6 to 7, 7 to 8, 8 to 9, 9 to 10, 10 to 11, 11 to 12 and 12 to 13 using a double logarithmic equation in the form of equation (1)

$$\log \text{weight} = a + b \log \text{height} \qquad \text{Eq (1)}$$

where "b" equals the exponential value and "a" a constant.
In this way proportional changes are not lost when only mean values are available according to Van Wieringen (1972).

RESULTS AND DISCUSSION

Exponential values for the age ranges, as discussed, are presented in Tables IV and V. The values show how much heightness is required for the investigated quantity weightness and thus the lower the exponent the less height is needed to express a given weight. From Table IV we see that modern children approach the theoretical value (w) = h^3 and comes in close agreement with Danish cross-sectional data (Asmussen and Heeböll-Nielsen, 1955) on subjects 7 to 16 where a height dimension value of 2.68 for boys and 2.88 for girls with weight was found. The differences in our values and those of Asmussen and Heeböll-Nielsen may be due to a difference in age range. One sees from Table IV that with increasing age range the exponential value increases - perhaps because there are more plottings points.

Table V expresses in fact the velocity of change between two age groups. From these values we can estimate whether the child is growing in height or weight. An increased exponential values indicates weight increases at a slightly higher rate with increasing height and similarily a decreasing value indicates weight increases are slightly lower to increasing height thus the child seems more linear.

TABLE III

Proportional Z-values for body weight for boys and girls based on the phantom stratagem

Age	Sex	1840	1924	1929/30	1960	1967/68 1971
6	M	1.10	.48	.86	.42	.11
	F	.86	.46	.83	.13	-.12
7	M	.60	.14	.32	.05	-.12
	F	.34	.05	.27	-.16	-.31
8	M	.07	-.17	.01	-.26	-.35
	F	-.15	-.29	-.11	-.21	-.56
9	M	-.34	-.34	-.40	-.34	-.48
	F	-.34	-.44	-.42	-.30	-.71
10	M	-.73	-.54	-.34	-.52	-.57
	F	-.63	-.66	-.51	-.36	-.79
11	M	-.91	-.66	-.61	-.62	-.66
	F	-.80	-.72	-.64	-.33	-.82
12	M	-1.08	-.74	-.53	-.48	-.70
	F	-.61	-.78	-.55	-.42	-.86
13	M	-.90	-.85	-.63	-.48	-.68
	F	-.67	-.82	-.65	-.31	-.56

Children accross the ages demonstrate the same pattern to increased weight rates with increasing height as they get older with the girls always being heavier between the ages 12 and 13 for there height except for in 1840 and 1930.

In comparing these values to z score values derived from the unisex phantom model similar results are noted. That is there is an increased tendancy to weightness with age and increased weightness for a given height accross the years. A didactic conclusion is that the use of a unisex reference model or phantom reveals the same tind of information as a dimensional analysis. The advantages of using a phantom model are conceptual clarity, ease in calculation and versatility in studying growth phenomenon for practically all anthropometric variables.

The findings from both these approaches evokes further questioning. Is the human design such that increasid stature is related to relative lightness ? Why is growth apparently more manifest in stature than weight in present day children ? Or for that matter, how valid are body surface areas formulae based on height and weight when these two parameters may be disproportional components in the morphological make-up of different subjects who may reflect ethnic, regional or secular differences from causes yet unknwon.

TABLE IV

Exponential values for mean height and weight values for an increasing age range

	1840		1924		1930		1960		1970	
	M	F	M	F	M	F	M	F	M	F
6 - 7	1.94	1.72	2.08	1.93	1.75	1.65	1.98	2.14	2.27	2.25
6 - 8	1.83	1.75	2.09	1.94	1.83	1.75	2.07	2.45	2.31	2.24
6 - 9	1.81	1.95	2.15	2.07	1.81	1.85	2.22	2.57	2.36	2.30
6 -10	1.79	1.99	2.18	2.15	2.00	1.97	2.27	2.63	2.42	2.38
6 -11	1.85	2.06	2.22	2.24	2.06	2.08	2.33	2.71	2.46	2.48
6 -12	1.92	2.23	2.28	2.32	2.18	2.27	2.46	2.74	2.50	2.55
6 -13	2.08	2.34	2.32	2.40	2.27	2.38	2.55	2.80	2.56	2.68

TABLE V

Exponential values for mean height and weight values between two age ranges from age 6 to 13 according to a double logarithmic formula

	1840		1924		1930		1960		1970	
	M	F	M	F	M	F	M	F	M	F
6 - 7	1.94	1.72	2.08	1.93	1.75	1.65	1.98	2.14	2.27	2.25
7 - 8	1.70	1.77	2.11	1.95	1.96	1.88	2.15	2.84	2.33	2.23
8 - 9	1.83	2.46	2.32	2.45	1.71	2.04	2.71	2.70	2.50	2.45
9 -10	1.70	1.96	2.24	2.32	3.25	2.60	2.31	2.77	2.65	2.69
10-11	2.39	2.45	2.49	2.47	1.92	2.53	2.62	3.11	2.61	2.87
11-12	2.34	3.63	2.66	2.77	3.25	3.34	3.61	2.73	2.78	2.83
12-13	3.75	2.73	2.52	2.88	2.63	2.58	3.02	3.30	3.33	5.18

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STATURE OF A GROUP OF MEDICAL STUDENTS AND OF THEIR PARENTS

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ABSTRACT

The heights of 50 male and 54 female students of Novi Sad University were compared with those of their parents. The mean height of male students was 3.72 cm more than that of their fathers, and the same of female students was 4.41 cm more than that of their mothers. The correlation coefficients for the height between fathers and sons /r = 0.768/ are higher than those between mothers and daughters /r = 0.641/. The difference in stature between students and their parents can be explained by secular increase in height which is typical for the studying youth.

INTRODUCTION

It is a well-known fact from special literature that contemporary children and young adults are taller than those of earlier generations /Meredith 1976/. Durnin and de Weir /1952/ compared the heights of students at Glasgow University with those of their parents. They found that the female students were 4.3 cm taller than their mothers, and the male students were 4.6 cm taller than their fathers.

Taking into consideration that there have not been examinations of this kind in Yugoslavia we set ourselves the task to find out the differences between the heights of the students and those of their parents.

MATERIAL AND METHODS

The students were measured is the Department of Biology at the Medical School at Novi Sad. Their heights were taken always in the morning by using Martin's anthropometer according to IBP technique. The students parents were measured at home /I should like to express my indebtedness to all students for their cooperation/.

The data thus obtained were calculated on the computer at the School of Agriculture at Novi Sad.

50 male and 54 female students of 18-19 years old, in their first year of study, were measured. Their parents were measured in the same number.

RESULTS

The data in Table 1 shows that the height of the male students /177.89 cm/ is 3.72 cm more than those of their fathers /174.18 cm/.

Table 1. Stature of fathers and their sons

	Fathers		Sons		Diff.	t
N	$\bar{x}$	SD	$\bar{x}$	SD		
50	174.12	6.39	177.89	4.03	3.72	3.50^{x}

The same refers to the female students /166.05 cm/ whose heights are 4.41 cm more than those of their mothers /Table 2/.

Table 2. Stature of mothers and their daughters

	Mothers		Daughters		Diff.	t
N	$\bar{x}$	SD	$\bar{x}$	SD		
54	161.64	6.18	166.05	5.47	4.41	3.93^{x}

The differences of mean values are in both cases statistically significant.

Correlation between the heights of the male students and those of their fathers is presented on Fig. 1. There is a strong correlation between the heights of the students and those of their parents /r=0.7681/. Similar data have been found with the female students,however, the coefficient correlation was somewhat lower: r=0.6418 /Fig. 2/.

The parallel regressive curves for the ratio between fathers--sons and mothers--daughters, respectively, are pre-

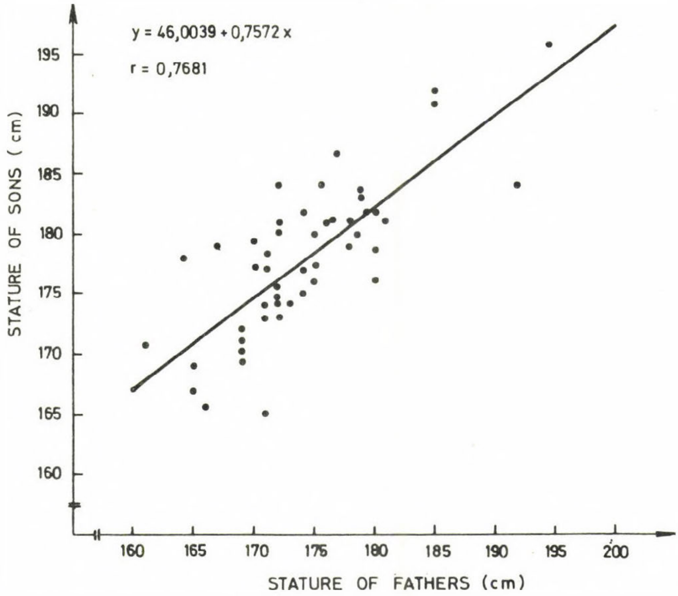

Fig. 1. Correlation between the height of male students and those of their fathers

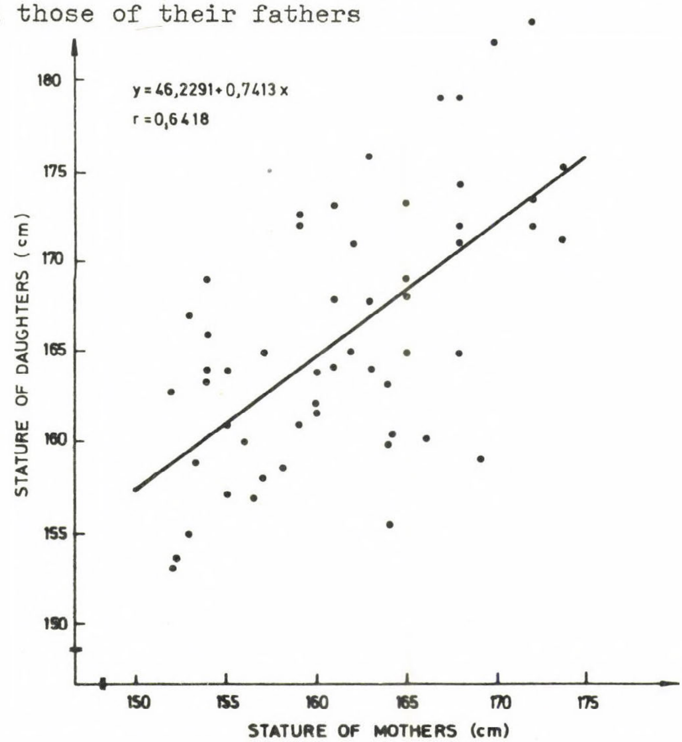

Fig. 2. Correlation between the height of female students and those of their mothers

sented in Fig. 3. The height increase of students has been grown with the height increase of their parents.

DISCUSSION AND CONCLUSION

In the present investigations we confirmed the findings of earlier English authors that students of both sexes have been taller than their parents. We also found that students of both sexes were very tall similar to the previous student population investigated at Novi Sad /Gavrilović 1972/.

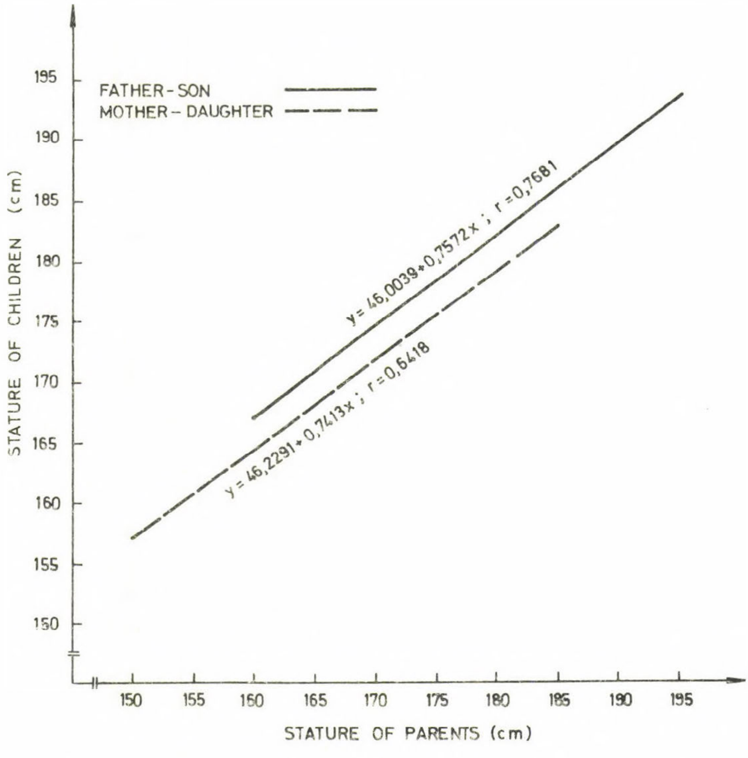

Fig. 3. The regressive curves for ratio between fathers—sons and mothers—daughters

The differences between the height of the male students and their fathers and of the female students and their mothers, respectively, could be explained in two ways. First there may have been a secular increase in height so that the students are taller now than their parents were at a comparable age; secondly, the parents, when they were young adults may have been just as tall as their offsprings are today but since then there has been a shrinkage in the parent's stature. In our opinion a longitudinal examination is necessary and a strict documentation of anthropometric data in Health Institutions. That would be the only possible way to obtain reliable answer and to avoid various explanations of this question.

On the basis of results obtained in this paper the following conclusions could be drawn:

1. The height of the male students was more than 3.72 cm than that of their fathers, and the height of the female students was 4.41 cm more than that of their mothers.

2. The stature correlation coefficient between male students and their fathers /r=0.76/ was higher than between female students and their mothers /r=0.64/.

3. Differences is statures between students and their parents were, in opinion of the author, related to the secular trend described in literature.

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GROWTH AND DEVELOPMENT OF CHILDREN AND ADOLESCENTS IN HIGH ALTITUDE REGIONS OF THE PAMIRS

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ABSTRACT

Based on our own data and materials by other authors we try to trace the effect of climate on processes of growth and development. More than 20.000 school children of different ethnic groups have been observed, among them Russians from different cities of the USSR. Buryats, Tadjics, Georgians and Kirghizians at high and low altitudes.

Growth patterns show little relatioship to climatic variations unless a population lives under extreme environmental conditions. E.g. sexual maturation of Russian chlidren turned out to be the same though they lived in different climatic zones: Middle Asia, the Caucasus, the North and in the Central European parts. Numerous papers dealing with the average age of menarche confirm that this characteristic is not influenced by race or climate.

It is not so with groups living under extreme conditions which cause physiological changes in the human organism, namely, groups living at high altitudes and in the tropics. At high altitudes populations /Kirghizians and Tadjics of the Pamirs, Indians of the Peruvian Andes/ develop slower and maturation is retarded compared to those divelling at plains and low altitudes. It is suggested that this slow rate of growth may be influenced by lowered function of the thyroid gland as an adaptive response to hypoxia as well as other important factors such as nutrition.

In the tropics the climatic factors also exert direct influence on growth patterns. The ration of body surface to weight is higher in tropical populations which is one of adaptive adjustments providing a more intensive level of heat exchange.

This leads us to conclude that living in the tropics and at high altitudes influences patterns of growth and development, thus adapting the organism to extreme environments.

INTRODUCTION

The question whether the climate influences growth processes has become of particular importance recently owing to the extensive development of new territories and population migrations. From this aspect the study of the populations of the Pamirs is very interesting.

MATERIAL AND METHODS

In 1968-69 the Institute of Anthropology of Moscow State University jointly with the Kirghizian State Medical Institute set up an expedition to the high altitude regions of the Pamir-Alai mountains. The study was made at the village of Kyzyl-Djar /Osh region, Kirghizian S.S.R./ situated at 2300-2800 m above sea lewel and isolated from the principal roads of the republic by steep ridges of the Pamir-Alai. The dwellers of these settlements are chiefly engaded in herding; in summer they nomade together with herds to thigh altitude pastures sometimes climbing up to 3500 m.

According to the collected ethnographic data the Kirghizians under examination came to their present habitat from Northern Kirghizia some 350 years ago.

As a control sample, in 1970 we studied Kirghizians from several villages of the Kirov district /Frunze region, 700-900 m a.s.l./.

The investigation was carried out, both at high and low altitudes by joining the efforts of anthropologists, pediatricians, neuropathologists, psychiatrists, physiologists and geneticians. The anthropological programme embraced over 50 measurements, characteristics of sexual maturation and constitutional traits, stages of permanent teeth eruption, dermatoglyphics, collection of materials on blood groups of ABO, MN, Rh and Lewis system. 100 adult males and 900 schoolchildren from 8 to 18 years of age were studied at high altitude; at the low altitude the number of subjects was 1200 children and adolescents of the same age range.

In 1971-72 an expedition of the Institute of Anthropology of Moscow State University investigated some Indo-Iranian speaking tribe of the Western Pamirs, belonging to the Caucasoid race type. In Gorno-Badakhshanskaya autonomous region 600 school-children aged from 12 to 17 years and 300 adult males were examined /altitude 2200 m a.s.l./.

RESULTS OF RESEARCH

According to their race-diagnosed traits, the studied Kirghizian group is a typical representative of the South Siberian Mongoloid race type. By their face, height and width, head measurements, tertiary hair cover, hair and eye pigmentation the population of high altitude is close to that from other regions of Kirghizia, especially of Southern Tien-Shan /Miklashevskaya et al. 1972a/. Among other race-diagnosed traits we also determined taste sensitivity to PTC. Under study were 70 objects, of whom 88.6% felt the taste, 11.4% did not, which seem to be within the variability of this trait in Mongoloid groups. The dermatoglyphic data also proved the conclusion on a close similarity between the high altitude population and other groups of Kirghizians /Miklashevskaya et al. 1972a/.

The results of anthropological investigation indicate a number of significant differences between the growth characteristics of children living at high and low altitudes. Children were more retarded at high altitude, since the processes of growth and pubescence were slowed down /Miklashevskaya 1972; Miklashevskaya et al., 1972 a,b; Miklashevskaya et al. 1973/. The average body dimensions in high altitude school-children are smaller than the analogous figures of the Kirghizians from low altitude areas. Thus, the high altitude boys on the average are 2 cm shorter than those from the low altitude; the difference in chest circumference is 1.5 cm, accordingly.

The comparison of the growth curves of the stature in Kirghizian boys and girls from high altitude has revealed a very interesting fact also observed in high altitude Indians from the Andes /Frisancho, Baker 1970/. The high altitude Kirghizians show only one crossing of growth curves for the age of 14 years and 3 months. Under 14 years and 3 months the statures of high altitude boys and girls coincide almost completely, and after this age point the boys begin to leave the girls behind. Growth curves of low altitude school-children are characterized by regular crossings at 10 years 10 months and 14 years 4 months. The growth curves for shoulder width also show one crossing at the point of 14 years 8 months from that age on the boys are ahead of girls. In Kirghizians of low altitudes the crossings of growth curves for shoulder width are found at the points of 10 years 8 months and 14 years 5 months.

The pubescence of high altitude adolescents is also retarded. Median age at which 50 per cent of girls at high altitude had already menstruated turned out to be 15 years 2 months, which is unusually late. Breast development is on the average 3.5 months behind in high altitude compared with the same in low altitude girls. The change of voice sets in on the average 6.5 months later and the development of axillary hair 8 months later in high altitude boys.

The processes of growth and pubescence for adolescents of Western Pamire are also slow /Miklashevskaya et al. 1974/. While studying the Kirghizians of the high altitude regions we could study a comparative control group having the similar racial type, it was quits impossible for the Iranian speaking tribes of the Western Pamirs because they inhabit only high mountain regions. That is why we had to take for comparison the data on the Russians of Moscow. The time of appearance of pubic hair and axillary hair in Pamirs boys was 4.5 months and 8.5 months later than in Russian school-boys. The moustache among Moscow school-boys appeared 10 months earlier than in boys of the Pamirs. The frequency of the non-zero stages of breast development at 12 years is almost equal in Caucasoid Pamir girls and Kirghizian girls - about 70%. In Kirghizian girls of the low mountain regions as well as in the Russians of Moscow this index at 12 years of age was found to be 89.5 and 91.1% respectively.

Data for eruption of permanent teeth are interesting. The total number of permanent teeth at different ages is approximately the same in both Kirghizian groups and among Leningrad school-children. This corroborates the opinion of many authors that dental development is less subject to environmental factors and basically is regulated by hereditary factors.

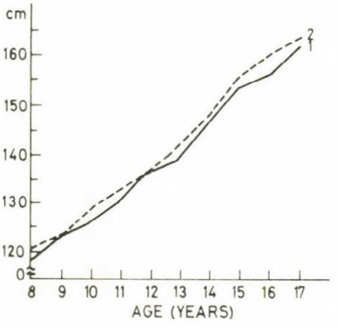

Fig. 1. Growth curves for stature of boys: 1. High altitude, 2. Low altitude.

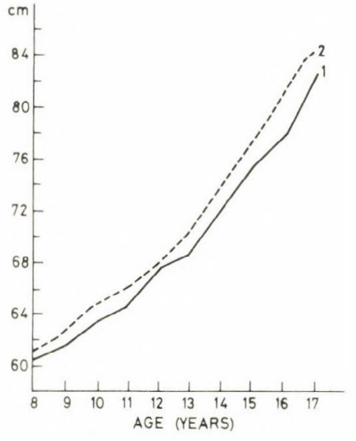

Fig. 2. Growth curves for chest circumference of boys: 1. High altitude, 2. Low altitude.

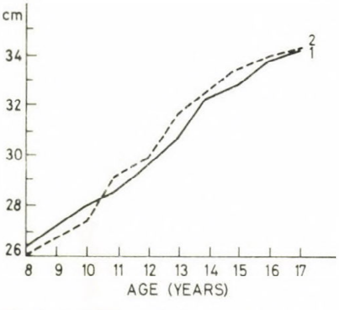

Fig. 3. Growth curves for biacromial diameter for girls: 1. High altitude, 2. Low altitude.

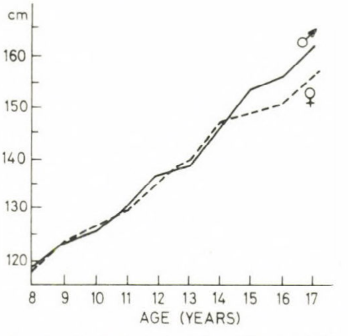

Fig. 4. Growth curves for stature of boys and girls in high altitude.

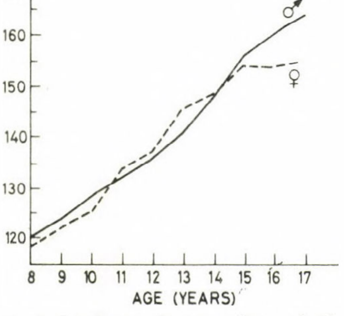

Fig. 5. Growth curves for stature of boys and girls in low altitude.

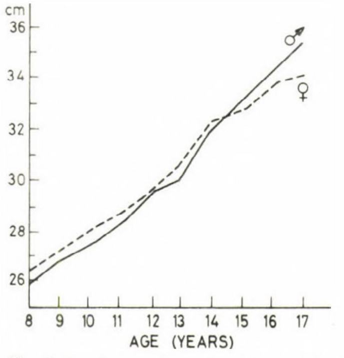

Fig. 6. Growth curves for biacromial diameter of boys and girl high altitude.

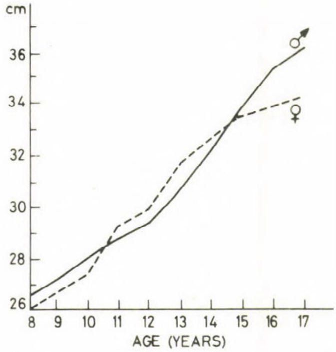

Fig. 7. Growth curves for biacromial diameter of boys and girls in low altitude.

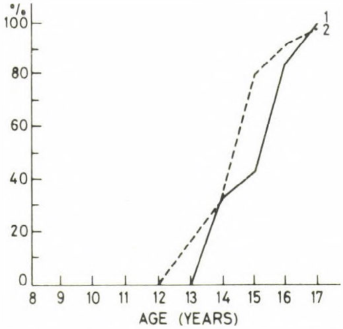

Fig. 8. Percent of girls who have already menstruated, by age: 1. High altitude, 2. Low altitude.

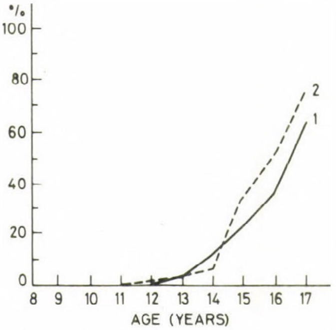

Fig. 9. Percent boys having already hair (irrespective of the stage of development of ax), by age: 1. High altitude, 2. Low altitude.

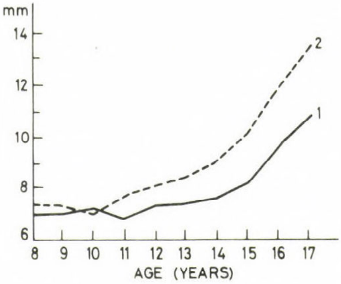

Fig. 10. Growth curves for triceps skinfold values for girls: 1. High altitude, 2. Low altitude.

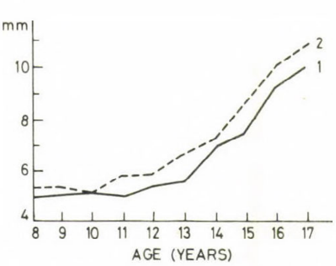

Fig. 11. Growth curves for subscapular skinfold values for girls: 1. High altitude, 2. Low altitude.

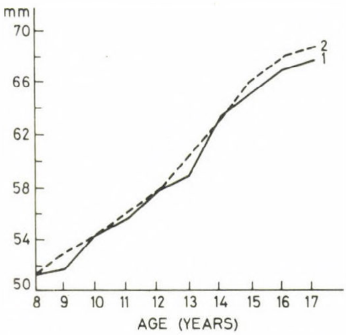

Fig. 12. Growth curves for diameter of the bicondylar humerus for boys: 1. High altitude. 2. Low altitude.

DISCUSSION OF RESULTS

According to the anthropological research, the processes of growth and pubescence in children and adolescents from the high altitude areas prove to be very much retarded as compared to those found in the inhabitants of the plain and low altitude regions.

What are the reasons for such retarded rates of physical development in the high altitude residents? Among the principal reasons we many cite their peculiar nutrition. Of certain influence may be also the factor of isolation which made unavoidable marriages between close relatives. There are cases of polydactilia discovered among the population of high altitude. But we do not think this factor of inbreeding to be decisive for the retarded physical development of the discussed population. The thing is that a similar picture was observed in some unisolated high altitude groups. According to Turusbekov /1970/ who studied physical development of school-children in the town of Naryn /2020 m a.s.l./ these children revealed prolonged physical growth an retarded pubescence. As reported by Baker et al. /2968/, his expedition studied the growth of children in the Peruvian Andes which are 4000 m above sea level. They found that population to be one of the most retarded in the world.

Results of functional research can be of great value for interpreting the data. The functional state of the cardiovascular system was examined mainly in adults at high altitudes. It was revealed that high altitude residents are characterized by a relatively low pulse rate, a slow rate of blood flow, a decreased level of arterial pressure and by a lower level of basal metabolism /Mirrakhimov 1968/. We believe that the latter is of particular significance. The level of basal metabolism is known to depend upon the function of the thyroid gland. Therefore, it is quite possible to suggest that at high altitudes the function of the thyroid gland decreases. And indeed, as proved by Kalyuzny and Belekova /1968/ with the help of radio-isotope diagnostics, the healthy aboriginal population of the high altitude of the Tien-Shan /2020 m/ and the Pamirs /3760 m/ show a hypofunction of the thyroid gland. These authors hold that a moderate hypofunctionof the thyroid gland is of adaptive and compensatory nature. It helps one to utilize oxygen more economically, which means that without the unnecessary strain for his respiratory and vascular systems, one easily gets adapted to the conditions of hypoxia. Following this, the observed hypofunction of the tyhroid gland in the high altitude people is their advantageous adaptive reaction.

The thyroid hormones do not only regulate the basis metabolism in man, they are of vital importance for the processes of physical growth and development too. Therefore, it may be suggested that the retardation of growth and development observed under high altitude conditions is a secondary adaptive response of the organism to hypoxis.

We understand that the peculiar nourishment and hypoxia are not the only factors affecting the rates of growth and development in the children and adolescents of high altitudes. In order to estimate all the various factors as full as possible new extensive investigations will have to be carried out.

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ANTHROPOMETRIC VARIABLES IN INDIAN POPULATION – AN ENVIRONMENTAL PERSPECTIVE

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ABSTRACT

This investigation aims at examining the association between climatic factors and body measurements as also at finding out the association between the anthropometric variables in the same climatic zone. The study comprises of 676 anthropometric reports from different parts of India. It has been observed that out of all the climatic factors, stature shows the highest negative association with average rainfall, leading to shorter stature in rain forests. The other two variables, viz. cephalic index and nasal index do not show any marked association with any of the isolated climatic factors. Association among the anthropometric variables in the same climatic zone (statewise) indicates that stature - nasal index shows a negative correlation in all states except Bengal where the other two (Stature - C.I. and C.I. - N.I.) do not show any particular trend.

INTRODUCTION

Man is best adapted to the environment in which he lives the consequence of interaction between heredity and environment. He should not be considered apart from his environment. Baker (1969) has rightly advocated that all biological differences between human populations are produced either by the differences in the genetic structure of the populations or by environmental differences, which stimulate contrasting ontogenetic process in the developing organism. When we attempt to explain the causes of these differences, whether genetic or ontogenetic, the most tenable answer is usually that they are the product of adaptation to the varying environments. Mills (1950) has observed that temperature is one of the major factors effecting the growth and development of the Human body. Roberts (1953) concluded that with the increase in the mean annual temperature of the environment there is a decrease in body weight. Support for the above contention comes from Malik (1976) in that the high altitude population from Ladakh are heavier than the Indian pooled Data (ICMR, 1972) at the age of 19 years. Walter (1971) reported that there is a recognizable relationship between body size and climatic factors. Schreider (1957, 1963) has studied different body measurement of the populations inhabiting different climatic zones to examine the cause and effect relationship between the environment and human body. He demonstrated that the higher ratio of body weight/body surface area is helpful in adapting to cold climate by reducing the heat loss by radiation. Hiernaux et al. (1975) have recently shown that the forest dwelling populations cluster on the lower part of the major axis of the log weight/height simultaneous distribution. Moreover, the shorter the body size the ratio between weight/surface tends to be lower in Sub-Saharan African populations.

The present study has two main aims of investigation.

1) to examine the effect of different climatic factors, viz., Altitude (mean), Relative humidity (%), Mean temperature of the year and Average annual rainfall on the following body measurements, i.e. stature, cephalic index and nasal index and

2) to determine the association among anthropometric variables in the same climatic zone

MATERIAL AND METHODS

The biological universe of the investigation comprises of 676 anthropometric reports on male adults from different parts of India by different authors. The number of studies

TABLE 1

Climatic variables in different climatic zones along with the number of studies reported and number of Individuals

	Populations	Number of studies reported	Number of individuals	Climatic variables			
				Mean Altitude (meters)	Relative humidity (%)	Mean temperature (°C)	Average annual rainfall (mm)
1	Punjab and Himachal Pradesh	16	1,303	234	71	20.4	54.1
2	Maharastra	119	9,385	290	70	24.4	110.1
3	Madras	52	2,077	16	74	27.7	101.2
4	Kerala	66	4,078	64	84	25.9	153.3
5	Mysore	47	2,159	921	77	20.4	76.9
6	Andhra Pradesh	33	1,321	545	69	24.5	63.7
7	Madhya Pradesh, Gujrat and Rajasthan	74	6,440	387	57	23.2	86.3
8	Assam and Meghalaya	38	3,150	1500	51	13.6	123.4
9	Delhi	10	485	216	56	22.7	59.5
10	Jammu & Kashmir	7	599	1586	81	10.5	47.0
11	Bihar	49	4,449	354	64	24.5	130.4
12	Uttar Pradesh	100	11,666	236	66	22.8	101.3
13	Bengal	65	5,482	6	73	25.9	131.8

reported (taken into consideration in the present study) in each state (climatic zone) are shown in Table 1.

Coefficient of correlation has been calculated using Multilinear Regression Programme (MULTR) by computer Model 360/IV to study association between climatic factors and anthropometric variables and between anthropometric variables among themselves taken from the same climatic zone.

RESULT AND DISCUSSION

Table 2 shows the values coefficients of correlation (r) between anthropometric variables and climatic factors. Stature shows a negative correlation with average rainfall, but it depicts a 'low' negative correlation with the rest of the three climatic factors. Cephalic index shows positive 'low' order correlation with altitude and relative humidity and negative 'low' order correlation with mean temperature and and average rainfall. Nasal index shows 'low' order positive correlation with altitude, relative humidity and mean temperature, while it shows positive correlation with average rainfall. It is pertinent to observe that the highest negative correlation occurs between stature and average rainfall while the highest positive correlation between nasal index and average rainfall.

Table 2

ASSOCIATION BETWEEN CLIMATIC FACTORS AND ANTHROPOMETRIC VARIABLES (VALUES OF r)

ANTHROPOMETRIC VARIABLES	CLIMATIC FACTORS			
	Mean Altitude	Relative humidity	Mean temperature	Average Annual Rainfall
Stature	- .079	- .167	- .053	- .445
Cephalic index	.086	.014	- .020	- .027
Nasal index	.088	.055	.086	.255

Hiernaux et al. (1975) have also reported relatively shorter stature in the rain forest. The probable reason given by them (Hiernaux et al. 1975) is that "the shorter stature of the rain forest population seems to be largely genetic in origin; it probably results from selective a pressure exerted by the thermal stress in the hot and wet biome where sweating is of low thermolytic efficiency. The amount of reduction of adult stature depends for a large part on the number of generations spent in the forest by the population". The present survey from India supports the findings and confirms the aforesaid causative factors (which are of thermolytic utility) responsible for the shorter stature in rain forests.

Thomson and Buxton (1923), Davies (1932) and Weiner (1954) have indicated a positive association of nasal index with temperature and more so with absolute humidity. Weiner (1954) put forward a hypothesis that the high nasal index of tropical populations by and large, reflects an anatomical condition which facilitates evaporation of water through the highly developed surface of the nasal passage, so that, inhaled air is moistened. The present data shows a positive association between nasal index and average rainfall indicating that either genetic factors or some other important causative factors are playing a role (which have yet not identified).

All the climatic factors seem to make little difference to the different body dimensions when taken in isolation. It reminds us of Schreider (1963) who asserted "Adaptation is brought about by a variety of means which considered in isolation, appear almost negligible. Yet, if we ignore them, we run the risk of rejecting, one by one, all the factors which taken as a whole, ensure the physiological success of a species".

The "Statewise" correlation coefficients between Stature-Cephalic Index, Stature-Nasal Index and Cephalic Index-Nasal Index have been presented in table 3. Stature-Cephalic Index varies from a high order positive correlation in Madhya Pradesh (= .630) to a high order negative correlation in Delhi (= -.547) Stature - Nasal index shows in all states except Bengal (= .405) negative correlation of various degree from high to low order (r = -.715) in Mysore to

Table 3

COEFFICIENT OF CORRELATION (r) AMONG ANTHROPOMETRIC VARIABLES

Populations	Stature & Cephalic index	Stature & nasal index	Cephalic index and nasal index
1) Punjab	-.457	-.517	-.139
2) Maharastra	+.279	=.489	-.375
3) Madras	-.048	-.574	-.112
4) Kerala	-.211	-.326	-.194
5) Mysore	+.412	-.715	-.518
6) Andhra Pradesh	+.071	-.060	-.385
7) Madhya Pradesh	+ .630	-.686	-.737
8) Assam	+.112	-.112	-.169
9) Delhi	-.547	-.396	+.305
10) Jammu & Kashmir	-.039	-.256	+.908
11) Bihar	+.392	-.533	-.511
12) Uttar Pradesh	-.069	-.283	-.181
13) Bengal	+.483	+.405	+.686

-.060 in Andhra Pradesh . Cephalic index - nasal index correlation varies from high order positive correlation in Jammu and Kashmir (= .908) to a high order negative correlation in Andhra Pradesh (= -.737).

The distributions in different categories of stature (tall, medium, short), cephalic index (brachycephalic, mesocephalic, dolichocephalic) and nasal index (platynhinae, mesorrhinae leptorrhinae) have been presented in table 4.

Comparative analysis of stature indicates that populations in the northern region of India (Jammu and Kashmir) are generally medium statured, whereas, they are medium to tall in Delhi area, the frequency of tall statured individuals increases in the Punjab. Central Indians are generally of medium stature although individuals with short stature are often encountered in Madhya Pradesh, which presents a picture similar to that of Assam and Bihar. People from Kerala

Table 4

Didstribution of stature, cephalic index and nasal index in different categories

States	Stature+			Cephalic index++			Nasal Index+++		
	Tall	Medium	Short	Brachy-cephalic	Meso-cephalic	Dolicha-cephalic	Platyr-rhinae	Mesor-rhinae	leptor-rhinae
1 Punjab	43.75	56.25	-	-	12.50	87.50	-	37.50	62.50
2 Maharastra	-	97.17	5.589	3.36	95.80	0.84	8.40	89.08	2.52
3 Madras	7.69	63.42	28.89	-	40.38	59.62	7.69	88.96	3.35
4 Kerala	-	24.24	75.76	-	16.67	83.33	21.21	78.79	-
5 Mysore	-	85.10	14.90	14.91	70.18	14.91	14.91	80.84	4.25
6.Andhra Pradesh	-	93.93	6.07	-	81.82	18.18	-	93.93	6.07
7 Madhya Pradesh	-	73.33	36.67	-	33.33	66.67	26.67	63.33	-
8 Assam	-	50.00	50.00	7.89	65.79	26.32	28.95	68.42	2.63
9 Delhi	10.00	90.00	-	-	10.00	90.00	-	10.00	90.00
10 Jammu & Kashmir	-	100.00	-	-	14.29	85.71	-	14.29	85.71
11 Bihar	2.04	51.02	46.94	-	36.73	63.27	26.53	53.06	20.41
12 Uttar Pradesh	2.00	92.00	6.00	-	4.00	96.00	5.00	56.00	39.00
13 Bengal	-	86.15	13.85	6.15	76.92	16.93	6.15	64.62	29.23

+ Stature Short = 150 cm to 160 cm Medium 160 cm to 170 cm Tall 170 cm and above

++ Cephalic index Brachycephalic Mesocephalic Dolichocephalic

+++ Nasal index Platyrrhinae Mesorrhinae Leptorrhinae (highest mean annual rainfall climatic zone) are comparatively shorter that their south Indian neighbourers from Madras, Mysore and Andhra Pradesh. This finding supports the earlier view of the present study that there is decrease in stature with increase in the average annual rainfall of its bitop.

A comparison of cephalic index in different states of India reveals that north and east Indians are generally dolichocephalic, whereas they are mesocephalic in Maharastra and Andhra Pradesh. Madhya Pradesh and Madras have mixed meso- and brachycephaly, but groups from Kerala are again dolichocephalic. This comparison, shows no fixed association between cephalic index and any of the climatic variables, thereby demonstrating that there is no mono causal relationship between climatic factors and cephalic index.

The observations on nasal index permit us to say that north Indians (in areas of compartively low rainfall), are generally leptorrhinae and as we move towards both east and south we find that they are mesorrhinae with some admixture of platyrrhinae. The highest percentage of platyrrhinae type (28.95%) are from Assam and Meghalaya i.e. places with quite an high average annual rainfall (123.4 cm.).

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NUTRITIONAL EVALUATION OF A VENEZUELAN INDIAN GROUP: CHAPARRO–YUPKA TRIBE

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ABSTRACT

In a nutritional survey carried out within the sub-tribe Chaparro, pertaining to the Yukpa tribe and located in Perijá, North of South America, - proteic malnutrition and a high disbalance in the caloric contents of the dietetic formulae was found, specially in small children. Statistics evidence that this situation is due to a combination of facts interrelated to social, economic and cultural standards, as well as public health, which affect food production, distribution, utilization and consumption of the same .

INTRODUCTION

According to the historian Alfredo Jahn (1927), all Yukpa indians are natives of Brazil and they expanded during the pre-Columbian period to the limits of Mérida (Venezuelan Andees). Upon the arrival of the conquerors - they were displaced up to the Perijá Mountain, as a consequence they scatered and grouped themselves into small sub-groups, originating thus, eight sub - tribes of Caribean linguistic filiation in the Venezuelan side: Irapa, Japreria, Macoíta, Pariri, Schaparru, Viakshi, Wasama and Rionegrinos (Ruddle, 1.971.).

Reichel-Dolmatoff (1960) points out that the indians named themselves "YUKPA", which means "tame natives", who together with the YUKO" natives or "fierce indians" who inhabit Colombia, show a series of common elements which made possible to classify them as a great cultural unit.

Natives of Chaparro practice an incipient agriculture by means of de - velopment of crops, such as banana, maize, cassava, yam and malangay This agriculture is very limited, utilizing few and rudimentary instruments. They survive by means of a crop system such as felling and burning of trees,which they complement with recollection, hunting and fishing.

Evaluation of the nutritional status of the Yukpa population is one of the objectives of the research being carried out by the Department of Human Biology of the Central University of Venezuela, on Micro-evolution in said population. Dietetic, clinical and biochemical studies were carried out in the urban and rural areas, which enabled us to get acquainted with the numberless nutritional problems in Venezuela (Bengoa, 1942; Cabrera and Bengoa, 1943; Vélez Boza, 1948; Liendo Coll, 1950; González Puccini and co-workers, 1951; Vélez Boza and co-workers, 1952; Vélez Boza and co workers, 1965; Vélez Boza and Ruphael, 1968; Bermúdez and co-workers, 1968). However, not - enough dietetic data has been obtained in native communities to classify - them quantitatively. (Vélez Boza, 1948; Vélez Boza and Baumgarter, 1962).

The nutritional survey of Chaparro, referred to in this study, was - carried out in September 1974, and is the second one performed within the - Yukpa tribe.[1.]

The general objectives of this research are to evaluate the nutritional status of the Chaparro indian population and the facts which condition the same; to achieve a knowledge of the rol that diet plays in the individual - nutritional status and its relation with the working capability, as well as to obtain the necessary data to plan and evaluate a program of applied nutrition. In order to achieve those objectives, nourishing practices were researched, as well as favorable and adverse cultural facts which influence nutrition so as socioeconomic conditions of the families, in order to relate those facts to their nutritional status.

MATERIAL AND METHOD

Information was obtained through a survey, comprising population data, food availability, environmental conditions, feeding habits, special diets and daily food consumption. The formulary was applied to the wife of each family chief of the Chaparro population; at the time of the survey, the community counted with 51 people grouped into 9 families, during September 14 and 15, 1974. The methodology presently used by INCAP in studies carried - out in Honduras (1969) and Guatemala (1962) was utilized.

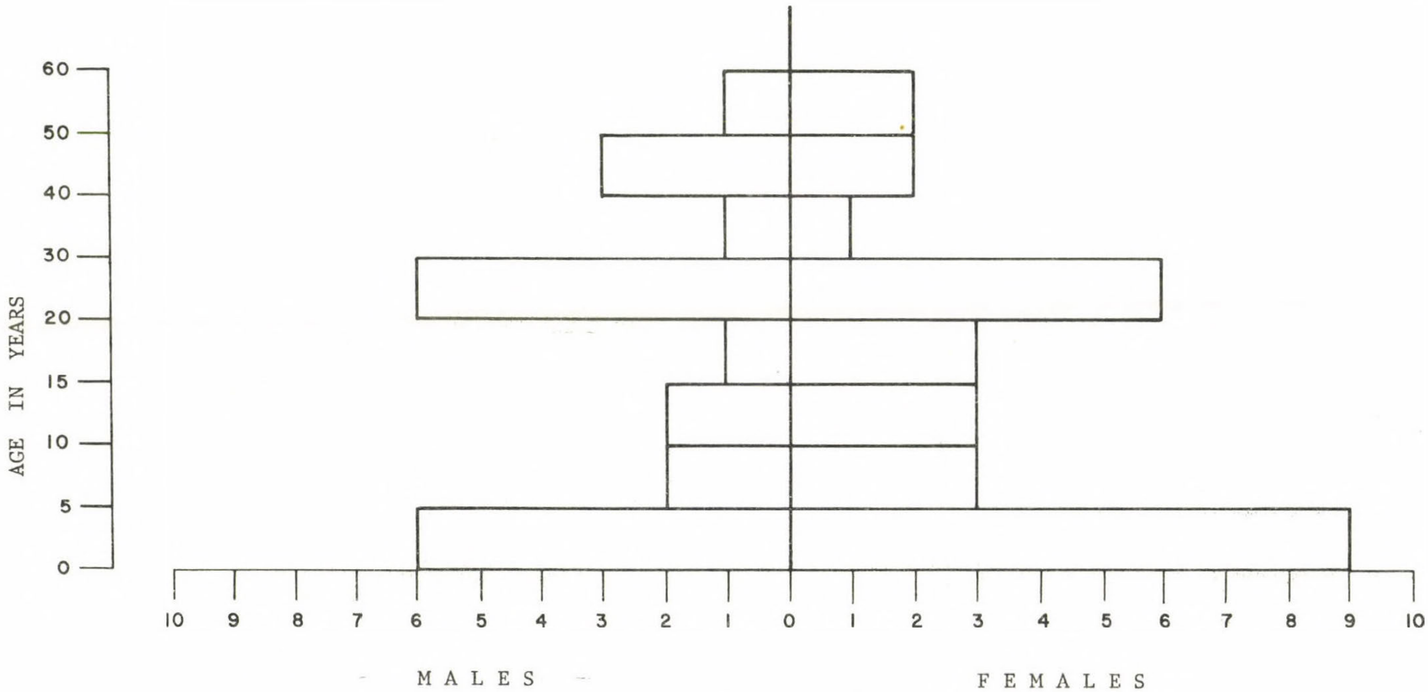
In order to evaluate the dietetic intake of the families, two methods were use (Reh, 1962) : 1) Daily Record: homes were visited twice daily,

1. The first nutritional survey within the Yukpa tribe was carried out by Lic. Elvira Quintero de Ramírez and cols. in Kasmera, sub-tribe Irapa, during 1972.

FIGURE N°. 1

POPULATION PYRAMID CLASSIFIED BY AGE AND SEX GROUP

CHAPARRO - PERIJA (1.974)



Population census for September 14, 1.974

during 2 consecutive days, in order to determine foods consumed by the family during each meal. Foods were weighed in raw, and registered the real consumption as well as the waste. 2) Direct weight method: Food was weighed during 2 days in raw and cooked form. In order to determine the consumption of each member of the family, wastage of each one was also weighed.

Weight, height, activity and number of commensals, including visitors were registered to obtain the average nutritional requirements for the same, following the standards of the "National Academy of Sciences of the U S A " (1969). In order to calculate calories and nutrients intake, the Table of Food Composition for Practical Use, Revision 1964, prepared by the National Institute for Nutrition - Venezuela, was used.

With the purpose to evaluate the adequateness of the diet, nutritional recommendations of the National Academy of Sciences of the U.S.A (1968) were utilized, as well as the Monograme of Sandiford and Boothby, reproduced from Du Bois, Basal Metabolism, Lea and Febiger, Philadelphia (White and cols., 1959).

RESULTS

Demographic values corresponding to the population of Chaparro for September 1974 are the following; 51 people grouped into 9 families; 22 males and 29 females. It was observed in the population pyramid (Figure I), the high frequency of infantile and young population (49.01 %), which is explained by a high birth and mortality rate when they come into transculturation. Causes of death are: fever, diarrhea, vomits and catarrh, suggestive of gastroenteritis, prematurity and pneumonias, which are closely related to the nutritional status of the population. (These data were obtained without a clinical or biochemical test due to lack of specialized staff).

Results corresponding to the average intake, requirements and adequation percentage of calories and nutritional elements of the studied families are given in Table N° 1.

TABLE N° 1

RECOMMENDATIONS, AVERAGE CONSUMPTION PER CAPITA / DAY AND PERCENTAGE OF CALORIES ADEQUATENESS AND NUTRIENTS OF 9 FAMILIES. CHAPARRO - PERIJA 1974.

Calories and Nutrients	Intake	Requirements	Adequateness
Calories	1903,62	2083.20	92,42
Total proteins (grs.)	43 00	53,67	76 77
a. Animals (grs)	6 09	-	-
b. Vegetables (grs)	36.91	-	-

Calcium (miligrams)	404.63	980.00	42.64
Iron (miligrams)	13.32	13.92	97.17
Vitamin "A" (U.I.)	1336.45	4328.63	61.63
Thiamine (miligrams)	1.18	1.17	109.04
Riboflavine (miligrams)	1.21	1.46	88.37
Niacin (miligrams)	10.59	15.46	67.76
Vitamin "C" (miligrams)	152.57	54.37	292.77

It may be said in reference to the calories, that the adequateness percentage per capita/day is satisfactory. Six families reached the adequateness percentage of 75% and more. Those calories are obtained in a high proportion from food like maize, sweet potato and malangay.

In relation to proteins, the adequateness percentage of total proteins is low (76.77%) but it should be notice that in 7 families the average percentage did not reach 75% and the two remaining families reached adequateness average levels of more than 150%. Concerning proteic quality, it may be - pointed out that the amount of animal protein is very low (6.09 grs.). Maize is the main source of proteins in the diet of Chaparro natives. Since this nourishement is of a "low" biologic value, this situation affects mainly - children, who need higher amounts of essential aminoacids per unit of body weight than adults. Upon studying percentual distribution (Table N°2), we observe a difference of -6.67% in relation to proteins, which confirms the low proteic intake.

In reference to Calcium, the intake was low with an average of 404.63 mg. per capita/day and did not reach 50% of adequateness. This average does

TABLE N° 2

PERCENTUAL DISTRIBUTION OF THE CALORIC VALUE OF THE NUTRIENTS TO THE DIETETIC FORMULAE. CHAPARRO - PERIJA 1.974

Nutrients	Grs.	Calories	Real Intake	Recommended Intake	Difference %
Proteins	43.00	172.00	8.33%	15 %	- 6.67
Fats	19.39	174.51	8.45%	30 %	-21.55
Carbohydrates	429.47	1717.88	83.23%	55 %	+28.23

Total Calories: 2.064

not cover the recommendations of this mineral. This evidences lack of milk and its by-products in the diet. The average intake of Iron was 13.32 mg., per capita/day, covering therefore the recommended amount. However, four - families had a lower intake than 75%. Maize is the main source of iron and being it a vegetable, it is absorbed in a lower proportion than iron of animal origin. In regard to Vitamin "A", the dietetic study evidences a very unsufficient intake and the average represents 61.63% of adequateness. The higher percentage of Vitamin "A" originates from sweet potatoes and malangay.

The adequateness percentage of Thiamine was 109.4%. However, three - families did not reach 75% of the adequateness levels. This number covers recommendations. The main sources for Thiamine are: cereals (maize cariaco) and tubercles (cassava, yam and malangay).

The average percentage for Riboflavine was of 88.37%. Only one family obtained the adequateness percentage of 362.9% which alters the final results of the average intake per person of 1.21 mg. of Riboflavine daily which does not picture the real situation. Niacin evidences a low adequateness percentage. The average intake of Niacin was of 10.59 mgs., reaching only 67.76% of the average adequateness. Two families reached levels of more than 100%.

Vitamin "C" covered in more than 100% recommendations, would indicate absence of a defficiency of Ascorbic Acid. The intake of milk products was very defficient, milk does not appear among the food and from its by-products only white cheese is present in the diet of two persons (the chief and his wife) among the population. Meat and eggs are scarcely eaten, eventhough - they have hens, chickens and turkeys Eggs are sold to the Tukuko Mission. Green and yellow vegetables are not eaten and fruit intake is low, except - for bananas which are consumed specially by children, this is possibly due to the fact that this survey was carried out in the time when no citrics - (oranges and grapefruits) were available.

Among vegetables, ocumo and cassava constitute the nutritional base for the community, followed by sweet potatoes and yam. They do not grant importance to the intake of legumes. Maize and wheat are among the cereals most consumed among all groups. All nine families utilize maize, specially as chicha (a local drink of yuca and maize cooked and ground). Wheat was utilized as bread, spaghetti and sweet cookies. Animal fat is utilized to prepare hallaquitas (a paste made of white maize mixed with chicken fat. - The paste is wrapped in maize leaves and cooked), and sugar is found in - carbonated drinks and candies

DISCUSSION

There is a high unbalanced condition in the caloric intake of the nutri ents with the dietetic formulae. Carbohydrates provide 83.23% of the total calories and there is a scarce intake of animal protein. New nutrients have been adopted with the progressive tendency to substitute the traditional ones for foods of more prestige but of a lower nutritional value, specially spaghettis and rice. The low intake and the inadequate availability, together with the defficient life conditions, cannot guarantee a good nutritional - status; consequently, working capability is not likely to be satisfactory.

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THE RATE OF INTRAUTERINE GROWTH IN CAUCASIAN, BLACK AND CENTRAL AMERICAN POPULATIONS BETWEEN THE 6TH AND 20TH WEEKS OF GESTATION

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ABSTRACT

The applicability of the growth-rate standards established for Caucasian embryos and fetuses to Black and Central American racial groups has been investigated. Comparison between menstrual age and crown to rump length indicated differences in the 10 to 15 weeks gestation range. However, growht-rates for the same groups were practically identical between the 15th and 20th weeks of pregnancy. This finding suggests that the actual rate of growth is closely similar in the respective ethnic groups and that apparent discrepancies reflect erroneous, or purposefully false, menstrual histories rather than dissimilar growth patterns. Largely indentical rates of development were suggested by the crown-rump length: foot length: body weight interrelations among the various racial groups.

INTRODUCTION

For half a century virtually all data relevant to early intrauterine development have rested on the standards of Streeter /1920/. Originally, these data had been based on actual measurements of human embryos and fetuses in the Embryologic Collection of the Carnegie Institution: a material that included spontaneosly aborted and ectopic specimens as well as those obtained by artificially induced abortion. Subsequently, the validity of the earlier established standards appeared to be confirmed by a comparative study involving human embryos, whose age was unknown, with monkey embryos with known copulation age /Streeter 1942, 1945, 1948, 1949, 1951/.

This highly hypothetical extrapolation from the rate of development of monkeys to that of humans has received a virtually unanimous recognition despite the warning of Witschi /1951/ who pointed out that such a projection was hardly realistic between two species of animals whose gestation length differed significantly. Only a few embryologists made appropriate corrections in human embryonic growth rate standards /Gasser 1975, Nishimura et al. 1968, Smith 1970/ when the present authors on the basis of measurements of human embryos obtained by therapeutic abortion, found that embryonic growth was a significantly slower process than Streeter had thought /Iffy et al. 1967, Jakobovits et al. 1972, Iffy et al. 1975/. It appeared necessary, therefore, to extend the study to a larger number of specimens and to establish growth rate patterns for various human races in order to pinpoint the causes of the discrepancies between Streeter's and the authors' data.

MATERIAL AND METHODS

The material for this study, consisting of over 1200 Caucasian embryos and early fetuses and obtained by artificial induced abortion, has been collected from the following sources:

1. The United States: /a/ Baltimore, Maryland; /b/ Los Angeles, California; /c/ Philadelphia, Pennsylvania.
2. Denmark: /a/ Copenhagen.
3. Hungary: /a/ Szeged; /b/ Budapest.

Two convenient parameters, namely crown-rump length and body weight, have been used for the definition of fetal maturity. Fetal age was expressed in terms of weeks calculated from the first day of the last menstrual period. The growth rate standards obtained by this investigation are compared in Table 1 with those of Streeter.

As an auxiliary parameter, suitable for the assessment of the stage of development in damaged products of conception, growth standards of foot length based on a comparison with crown-rump length have been developed. The obtained standards were compared with similar data based on about 700 specimens, from two other racial groups:

/a/ American Negro; /b/ Central American /racially mixed/.

RESULTS

As indicated in Table 1 the data based on the investigation of specimens obtained by therapeutic abortion differ significantly from those developed through alternative methods. The evidence indicates that the rate of growth of human embryos is slower than indicated by Streeter's data. A maximum discrepancy is demonstrable between 7 and 9 weeks of gestation and the differences disappear towards the middle of the second trimester. Interestingly, the crown-rump length versus body weight ratios were found higher in this, than in Streeter's study.

For obvious reasons menstrual age is the least reliable, even if the most important, parameter of fetal development. Table 2 indicates that around the borderline of the first and second trimesters in both groups /Black and Central American/ fetuses were too large for their menstrual age. After the 15th week of gestation these discrepancies disappeared and the averages were practically identical with those based on Caucasian products of conception.

The general trend of intrauterine growth rate was the same in the Negro and Central American groups as in the Caucasian material. A minor, but not statistically significant, difference was noted in the foot length of Negro embryos where the latter parameter, as compared to sitting height, was somewhat higher than in the other groups.

There was a relatively high number of deviations from the average standards in Black and Central American groups; almost certainly the result of inaccurate menstrual histories. However, the general trends of growth rate clearly indicate a largely identical pattern supporting the established consensus that the well-known differences in birth weigth among various racial groups develop in the last trimester due, presumably, to nutritional factors.

DISCUSSION

In the areas where our investigations were undertaken, Black and Central American populations represent economically

Table 1

Embryonic and early fetal growth rate standards according to Streeter and the authors

Week of gestation	Standards of Streeter crown-rump length /cm/	Standards of Streeter weight /g/	Standards of authors crown-rump length /cm/	Standards of authors weight /g/
6	0.55		0.5	
7	1.2		0.8	0.07
8	2.25	1.1	1.5	0.22
9	3.1	2.7	2.5	0.88
10	4.0	4.6	3.5	3.5
11	5.0	7.9	4.6	6.0
12	6.1	14.2	5.7	11.0
13	7.4	26	6.8	19.0
14	8.7	45	8.1	33.0
15	10.1	72	9.4	55.0
16	11.6	108	10.7	80.0
17	13.0	150	12.1	120.0
18	14.2	198	13.6	170.0
19	15.3	253	15.3	253.0
20	16.4	316	16.4	316.0

Table 2

Correlations between menstrual age and crown rump length in various ethnic groups

Black

Age group /days/	Crown-rump measurements /mm/	No. of cases	Standard deviations of crown-rump length /mm/
78-84	116.00	2	21.21
85-91	98.00	2	35.36
92-98	111.67	12	33.13
99-105	122.50	12	35.45
106-112	123.11	28	22.21
113-119	121.56	32	27.43
120-126	137.52	31	25.86
127-133	144.47	38	27.05
134-140	155.83	18	24.03

Caucasian

Age group /days/	Crown-rump measuremnets /mm/	No. of cases	Standard deviations of crown-rump length /mm/
78-84	63.19	35	22.07
85-91	82.85	44	30.83
92-98	83.11	42	20.08
99-105	100.90	31	36.02
106-112	116.00	33	36.25
113-119	118.81	55	31.84
120-126	133.81	73	20.61
127-133	144.06	61	19.14
134-140	154.20	53	27.92

Central American

Age group /days/	Crown-rump measurements /mm/	No. of cases	Standard deviations of crown-rump length /mm/
78-84	64.38	4	18.78
85-91	118.60	5	46.88
92-98	96.50	10	17.38
99-105	114.87	15	23.35
106-112	113.89	18	20.11
113-119	130.12	33	24.48
120-126	113.59	39	22.39
127-133	137.18	17	19.10
134-140	158.42	19	26.36

and educationally underprivileged groups. There is little doubt that this fact associated, perhaps, with mistrust towards the physicians on whose decision the fate of the patient's request for abortion rested, was responsible for many unreliable menstrual histories.

Since the range of inaccuracy in the menstrual histories of Black and Central American women clearly exceeds any possible difference in early intrauterine growth rate between Caucasians and Black and Central American groups, our study cannot prove, or disprove, with certainty the existence of such variations. The evidence is suggestive, however, that race related differences are either absent or insignificant in early gestation. Accordingly, it is proposed that between 6 and 20 weeks gestation the earlier established growth rate standards of Caucasian embryos and fetuses /Iffy et al. 1975/ should be applicable to all racial groups included in this study with the only exception of foot length where an appropriate adjustment should be considered for Black fetuses. While on account of their small number we eliminated Oriental specimens from the investigation our impression, that their growth rates followed the Caucasian standards closely, is worth mentioning. It seems likely, therefore, that the proposed standards, as well as their earlier described limitations, are also applicable to racial groups not included in this material.

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EARLY INTRAUTERINE DEVELOPMENT: THE EFFECT OF MATERNAL AGE, PARITY, SEASONAL VARIATIONS AND FETAL SEX

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ABSTRACT

Analysis of the data revealed no evidence of any consistent difference among the patterns of growth in the maternal age, maternal parity, or fetal sex categories. The mean body weight was consistently higher when conception occurred during the summer than when it occurred during the fall or winter. However, the analysis of mean crown-rump length by menstrual age did not yield a significant reasonal effect.

INTRODUCTION

In a previous report evidence was presented indicating that early intrauterine development, when based on investigation of normal embryos and fetuses obtained by artificially induced abortions, was a lower process than earlier studies had suggested /Iffy et al. 1975/. In a further paper presented earlier at this meeting, it was shown that the growth rate pattern was identical in the three ethnic groups investigated, i.e. Caucasians, American Blacks and racially mixed Central Americans /Jakobovits - Iffy 1976/. Since there is evidence to indicate that maternal age and parity have significant bearing on average fetal weight at, or around, term /Karn - Penrose 1952, Karn 1953/, the question whether similar differences could be demonstrated in the first twenty weeks of gestation appear to be one of interest. Because there is evidence in the literature indicating that birth weights are influenced by seasonal variations /Salber - Bradshaw 1952/ and because our computerized data of a total of 1672 specimens contained a fair amount of information in this respect, the investigation has been extended into this parameter also. Furthermore, the effect of fetal sex on fetal growth in the first half of gestation was analyzed in the same manner.

MATERIAL AND METHOD

The selected procedures of obtaining and measuring specimens have been discussed in previous studies /Iffy et al. 1975, Iffy et al. 1967, Jakobovits et al. 1972/. With regard to maternal age the available 911 specimens were divided into 3 groups: a/ Maternal age under 20 years, b/ age between 20 and 29 years and c/ age of 30 and above.

A total of 832 specimens provided information about maternal parity. Here the groups were subdivided in the following manner: a/ nulliparous women, b/ mothers with parity of 1 or 2 and c/ multiparous women with 3 or more childbirths.

The 816 specimens that offered menstrual data so that the season at the time of conception could be defined, were divided into 4 groups on the basis of the reported onset of the last menstrual period: a/ spring, b/ summer, c/ fall and d/ winter. The groups were established on the basis of the assumption that the first day of the last menstruation was the beginning of the reproductive process that resulted in the embryo or fetus in question.

Fetal sex specified in 671 specimens. The determinations were based on inspection of the external genitalia: the only widely available method at the time when this study began over 15 years ago.

Crown-rump length and menstrual age were used as parameters of embryonic and fetal growth in one analysis, the result of which is indicated in Table 1.

Crown - rump length and body weight were compared in Table 2 with reference to the knowledge that weight gain preceeds the decrease of linear growth in cases of growth retardation.

The data in Tables 1 and 2 were cast in a series of two-way tables with the rows representing menstrual age in days /Table 1/ or crown-rump length categories /Table 2/, and the

Table 1

Correlations between menstrual age and crown-rump length: the effect of maternal age, parity, season and fetal sex

Gestation length: Menstrual age in days	Mean crown-rump length in millimeters /mm/ Maternal age /years/			Parity			Season				Fetal sex	
	-19	20-29	30-	0	1-2	3+	Spring	Summer	Fall	Winter	Male	Female
35 - 42	14.0	-	-	14.0	-	-	14.0	-	-	-	-	-
43 - 49	-	10.8	9.3	-	10.3	9.5	10.9	-	-	9.9	-	-
50 - 56	9.5	17.8	16.9	17.6	14.6	19.3	17.5	11.0	-	18.0	-	-
57 - 63	-	19.9	25.5	15.6	25.5	22.8	26.9	-	-	21.9	-	-
64 - 70	25.5	27.3	25.7	30.5	24.9	27.8	25.2	34.6	42.7	23.6	72.0	85.0
71 - 77	-	45.8	32.0	62.5	38.0	39.8	32.0	21.0	93.0	45.5	-	79.5
78 - 84	110.0	105.1	50.0	92.6	93.6	97.6	-	87.7	131.0	91.9	100.7	89.5
85 - 91	112.8	107.8	107.2	116.6	111.0	101.4	-	113.7	103.8	111.3	110.2	113.2
92 - 98	113.3	101.7	103.6	112.5	92.6	105.7	76.0	101.1	96.9	128.7	93.7	109.6
99 - 105	120.2	114.7	101.7	123.3	109.8	110.1	112.5	116.2	109.9	110.6	109.5	116.9
106 - 112	121.8	117.8	125.5	119.9	117.0	123.2	104.6	125.0	117.7	118.7	120.6	119.6
113 - 119	126.5	124.9	124.9	123.5	129.9	123.0	118.3	125.1	126.7	127.6	126.6	126.8
120 - 126	136.5	134.0	131.1	134.1	136.2	129.5	131.6	134.6	136.2	133.5	137.7	131.2
127 - 133	144.0	142.1	137.0	143.5	141.8	140.4	149.3	138.9	142.0	140.7	142.3	141.6
134 - 140	152.6	150.5	154.1	144.7	151.9	158.0	166.1	144.9	152.6	152.8	149.1	153.7
141 - 147	162.0	152.3	158.8	155.9	151.8	161.3	139.5	158.9	162.1	158.6	154.1	158.3
148 - 154	174.3	146.7	170.0	164.2	157.7	144.0	134.0	158.3	158.7	-	147.6	163.7

Underlined mean values were based on less than 5 observations.

Table 2

Correlations between crown-rump length and birth weight: the effects of maternal age, parity, season and sex

Crown-rump length /mm/	Mean birth-weight in grams /G./ Maternal age /years/			Parity		
	—19	20–29	30–	0	1–2	3+
20 – 24	–	1.0	–	–	–	1.0
25 – 29	–	–	1.0	–	1.0	–
30 – 34	–	–	–	–	–	–
35 – 39	–	–	–	–	–	–
40 – 44	–	–	–	–	–	–
45 – 49	–	–	–	–	–	–
50 – 54	5.0	–	5.0	–	5.0	5.0
55 – 59	–	–	–	–	–	–
60 – 64	–	–	–	–	–	–
65 – 69	–	17.7	–	–	15.0	20.5
70 – 74	22.5	15.0	19.0	22.5	22.0	10.0
75 – 79	–	45.0	–	–	80.0	10.0
80 – 84	–	30.8	12.5	15.0	16.7	36.2
85 – 89	17.5	30.4	63.0	17.5	25.7	56.7
90 – 94	–	50.0	15.0	47.5	55.0	15.0
95 – 99	60.0	44.4	51.6	60.0	51.7	44.4
100 – 104	57.5	61.8	75.8	57.5	58.0	79.0
105 – 109	68.7	83.5	75.0	75.8	67.9	91.2
110 – 114	93.0	97.2	103.7	85.6	100.8	96.9
115 – 119	111.4	113.5	91.4	112.3	113.5	97.5
120 – 124	126.2	120.6	110.0	131.4	115.0	108.6
125 – 129	140.6	138.0	170.5	147.7	135.0	154.1
130 – 134	151.4	154.4	165.5	154.0	146.4	165.0
135 – 139	172.0	184.7	163.0	173.6	175.4	181.9
140 – 144	184.4	193.9	210.0	192.0	190.5	185.7
145 – 149	208.3	203.7	204.1	207.8	207.2	198.1
150 – 154	248.0	228.5	300.0	244.4	231.7	242.0
155 – 159	278.5	270.4	269.0	275.4	271.8	272.9
160 – 164	268.4	295.0	350.0	283.7	283.7	324.0
165 – 169	308.3	307.2	310.0	341.0	285.0	311.7
170 – 174	310.0	348.7	310.0	406.7	337.8	310.3
175 – 179	361.1	362.5	400.0	373.0	344.3	345.0
180 – 184	440.0	400.0	–	423.3	395.0	405.0
185 – 189	470.0	421.2	475.0	440.0	442.5	425.0
190 – 194	487.0	490.0	445.0	495.8	465.0	445.0
195 – 199	495.0	480.0	–	490.0	510.0	466.7
200 – 204	560.0	550.0	400.0	541.2	–	502.5
205 – 209	573.7	–	–	573.7	–	–
210 – 214	675.0	630.0	–	661.7	625.0	–
215 – 219	650.0	–	560.0	638.0	–	495.0
220 – 224	–	–	–	–	–	–
225 – 229	–	–	–	–	–	–
230 – 234	–	–	–	–	–	–
235 – 239	494.0	845.0	–	494.0	845.0	–

Table 2

/continued/

Crown-rump length /mm/	Mean birth-weight in grams Season Spring	 Summer	 Fall	 Winter	 Fetal sex Male	 Female
20 - 24	-	-	-	<u>1.0</u>	-	-
25 - 29	-	-	-	<u>1.0</u>	-	-
30 - 34	-	-	-	-	-	-
35 - 39	-	-	-	-	-	-
40 - 44	-	-	-	-	-	-
45 - 49	-	-	-	-	-	-
50 - 54	-	-	<u>5.0</u>	<u>5.0</u>	<u>5.0</u>	<u>5.0</u>
55 - 59	-	-	-	-	-	-
60 - 64	-	-	-	-	-	-
65 - 69	-	-	-	<u>20.3</u>	<u>20.0</u>	<u>15.0</u>
70 - 74	-	<u>19.0</u>	<u>15.0</u>	<u>25.0</u>	<u>15.0</u>	<u>22.5</u>
75 - 79	-	<u>80.0</u>	<u>10.0</u>	-	<u>80.0</u>	<u>10.0</u>
80 - 84	-	<u>100.0</u>	<u>16.2</u>	<u>15.0</u>	17.0	<u>41.7</u>
85 - 89	-	<u>67.5</u>	<u>32.5</u>	<u>20.7</u>	<u>35.0</u>	44.1
90 - 94	-	-	<u>36.7</u>	<u>55.0</u>	-	<u>50.0</u>
95 - 99	-	<u>100.0</u>	40.0	<u>70.0</u>	36.0	<u>55.7</u>
100 - 104	-	76.7	62.9	55.8	63.7	64.1
105 - 109	-	86.0	75.0	69.0	77.2	83.3
110 - 114	-	106.7	87.6	93.5	97.5	97.3
115 - 119	-	132.1	102.8	104.6	113.9	103.7
120 - 124	<u>160.0</u>	132.0	116.8	119.1	124.2	118.6
125 - 129	-	169.1	137.6	125.0	143.6	146.4
130 - 134	-	174.6	140.4	145.9	154.4	160.8
135 - 139	-	203.2	161.9	168.5	172.4	180.4
140 - 144	-	206.4	185.8	182.5	198.7	181.5
145 - 149	-	219.7	198.3	205.0	200.1	212.7
150 - 154	<u>219.0</u>	<u>256.2</u>	228.3	242.0	232.3	256.9
155 - 159	-	287.1	267.2	249.0	274.1	273.0
160 - 164	-	331.7	278.5	285.0	297.7	299.6
165 - 169	-	328.7	278.3	287.5	324.4	290.0
170 - 174	-	383.4	278.7	-	352.6	332.0
175 - 179	-	<u>367.5</u>	357.6	<u>260.0</u>	383.0	335.0
180 - 184	-	<u>435.0</u>	416.0	<u>381.7</u>	428.3	<u>407.5</u>
185 - 189	-	<u>445.0</u>	<u>405.0</u>	<u>430.0</u>	<u>435.0</u>	<u>453.0</u>
190 - 194	<u>520.0</u>	<u>505.0</u>	<u>438.3</u>	<u>420.0</u>	<u>468.7</u>	480.0
195 - 199	-	<u>520.0</u>	<u>490.0</u>	<u>420.0</u>	<u>480.0</u>	486.0
200 - 204	-	<u>481.7</u>	<u>560.0</u>	-	<u>480.0</u>	<u>552.5</u>
205 - 209	-	<u>500.0</u>	<u>600.0</u>	<u>600.0</u>	<u>565.0</u>	<u>600.0</u>
210 - 214	-	<u>700.0</u>	<u>650.0</u>	<u>630.0</u>	<u>652.5</u>	-
215 - 219	-	<u>638.0</u>	<u>495.0</u>	-	<u>495.0</u>	<u>638.0</u>
220 - 224	-	-	-	-	-	-
225 - 229	-	-	-	-	-	-
230 - 234	-	-	-	-	-	-
235 - 239	-	<u>494.0</u>	-	<u>845.0</u>	<u>669.5</u>	-

Underlined mean values were based on less than 5 observations.

columns representing sub-groups of maternal age, parity, season of conception or fetal sex. The mean scores in each row /crown-rump length in Table 1; birthweight in Table 2/ were ranked and the hypotheses that fetal growth was independent of maternal age, parity, season of conception or fetal sex were tested by means of the Friedman Two-Way Analysis of Variance by Ranks procedure /Siegel 1956/. Fetal growth was measured by means of /1/ mean crown-rump length by menstrual age in days and /2/ mean birthweight by crown-rump length in 5 mm intervals.

RESULTS

The subdivision of the material into numerous relatively small subgroups resulted in a considerable scatter of the calculated mean values in the several table cells. Analysis of the data by means of ranking procedures revealed no evidence of any consistent difference among the patterns of growth in the maternal age, maternal parity, or fetal sex categories. However, the analysis of mean birth weights by crown-rump length groups /Table 2/ yielded a highly significant /$p < .001$/ seasonal effect. The mean body weight was consistently higher when conception occurred during the Summer than when it occurred during the Fall or Winter /there were too few cases of Spring conceptions to be included in the analysis/. A similar seasonal effect was observed in a subgroup of the study population consisting of specimens obtained from Los Angeles hospitals. However, the analysis of mean crown-rump length by menstrual age did not yield a significant seasonal effect. Perhaps this was due to the inherent difficulties in accurately measuring menstrual age.

DISCUSSION

The findings support the concept that, while subject to individual variation, early intrauterine development is not likely to be influenced significantly by maternal age and parity or by fetal sex. It is more likely that these factors exert their influences in the more advanced stages of development. However, a preliminary statistical analysis suggests that the season of conception may have a significant effect on early intrauterine growth. In the study population, conceptions occurring during the Summer season resulted in consistently advanced levels of development as compared with conceptions occurring during the fall or winter seasons. Further analyses are under way to determine whether this finding can be explained by other associated variables. A more comprehensive statistical evaluation is also being undertaken to determine the extent to which the four factors herein considered interact among themselves and/or with other descriptive variables to affect early fetal growth and development.

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DISTRIBUTION OF THE NEW-BORNS WITH LOW BRITH-WEIGHT BY SEASONS AND BY SETTLEMENT TYPE ACCORDING TO LIVE-BIRTHS IN 1970

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Introduction

One of the essentially important factors of nursing the new-born babies - beside vitality and health status - is the physical development and within this the birth-weight. The healthy live-born with a weight of 2500 g or more is nursed normally in the department of new-borns; the survival and development of babies born alive with a weight under 2500 g are supported by special nursing in the department for premature infants. The majority of deaths in infancy, being regrettably still too high, occurs among premature babies belonging to various groups of birth-weight.

Thus, it is no mere chance that researchers investigate the factors potentially influencing birth-weight - over and above the causes indicating the beginning of birth before term. The data to be processed were put at our disposal by the Dept: of Population Statistics of the HCSO.

As our first step we investigated the distribution of the live-born of 1970 by their birth-weight and by months. The first question was whether any fluctuation did occur in the monthly frequencies of the various groups of weight. If difference was found, then any possible interrelation existing between the different monthly frequencies of the weight-groups and the seasons should be investigated. If in the investigated year any seasonal relation could be detected, it should be studied whether such phenomenon could be observed in other years, too - and if so, were their tendencies similar or different.

It should be examined whether or not the proportions of the seasonality are the same for babies with normal weight and for those with low weight.

Further, that should also be studied, whether or not significant differences existed between the seasonal interrelations of infants born in settlements of different type /Budapest, towns, villages/.

Our study aims answering these questions.

We have to mention that Breitinger /1972/, performing investigations on persons of military age, found certain relation between their height of body and the month of their birth.

Material and method

Our material concerns those live-born babies who were born in 1970 in Hungary and whose birth-weights were evaluable. Out of 151,812 new born 1.84 per cent had a birth-weight less than 1500 g, 8.86 per cent 1500-2499 g and 89.30 per cent had a birth-weight 2500 g or more.

Seasonal classification of the months was done according to meteorological seasons.

Season I: 3rd, 4th and 5th months; Season II: 6th, 7th and 8th months; Season III: 9th, 10th and 11th months; Season IV: 12th, 1st and 2nd months.

The individual seasonal-indices and the seasonal differences were calculated on the basis of the following formulae:

$$\bar{\bar{Y}} = \frac{\sum_{i=1}^{n} \sum_{j=1}^{m} Y_{ij}}{n.m} \qquad \bar{\bar{Y}} = \frac{\sum_{i=1}^{n} Y_i}{n}$$

The relations were examined by the help of the following formulae:

$$\chi^2_{[(k-1)(l-1)]} = \frac{1}{\bar{p}\,\bar{q}} \left[\sum \frac{a_i^2}{n_i} - \frac{A^2}{N} \right]$$

resp.

$$\chi^2_{[(k-1)(l-1)]} = \sum \frac{(T-O)^2}{T}$$

where T = theoretical value

O = observed value

Evaluation of the results

1/ Concerning the monthly frequencies of the various weight-groups of the infants born and investigated in 1970 the following have been found: the maximum of each weight-group occurs in the first half of the year. The deviation of the frequencies from the monthly mean is the smallest in the normal group /weight 2500 g or more/, and it is the most significant in the group of those born with a birth-weight of 1500-2499 g. The characteristic of the weight-group under 1500 g, is that the minimal frequency occurs in the 8th, month, while this minimum in the group of 1500-2499 g is in the 9th month and that of the group of 2500 g or more occurs in the 11th month /Table 1. and Fig.1/.

2/ The comparison of these findings has been performed with the data of the years 1972 and 1973.

The seasonal indices of the new-born of these three years have been studied for premature babies /with a birth-weight 2499 g or less/ and for normal ones /with a birth-weight of 2500 g or more/ /Fig. 2/

The seasonal fluctuation of all the infants and that of the normal new-born shows only insignificant deviations from the mean: in the two first seasons some +5 per cent above it, in the third season about - 5 per cent below it, and in the fourth season the deviation is -4 per cent from the mean. In the case of premature babies in the first season the deviation is +7 per cent, in the second one - 1 per cent, in the third season - 7 per cent and in the fourth one +1 per cent.

Thus, one can state that the seasonality found in the case of the new-born of 1970 is not a special phenomenon; in other years similar interrelations can be observed.

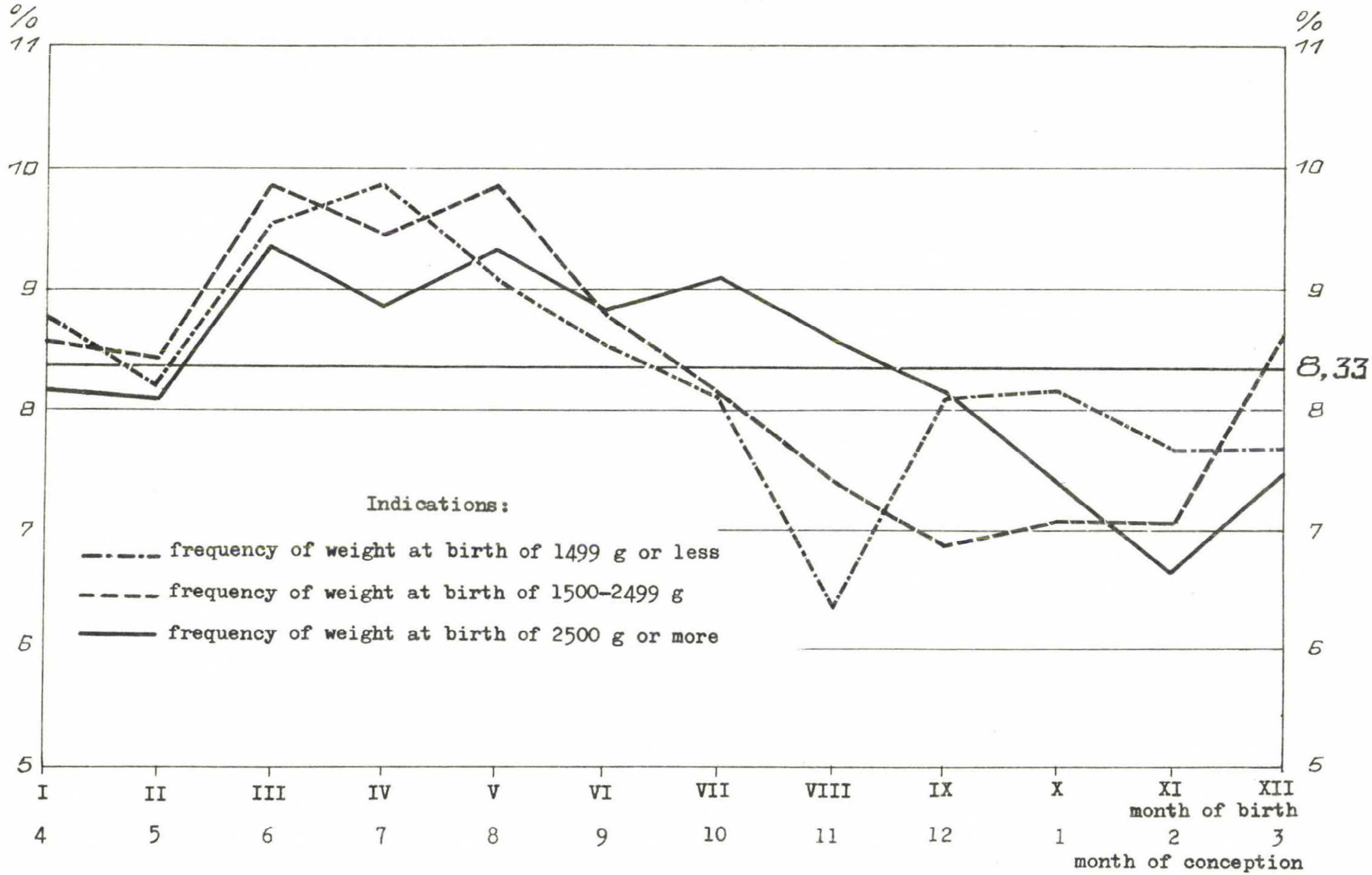
3/ Seasonal frequencies of new-born of towns and villages /in 1970/ were studied separately for the various weight-groups. When examining the relation between the seasonal frequencies of all births and that of normal weight-group by the help of chi-square probe for towns /including Budapest/ and for villages, highly significant values /$P < 0.001$/ were obtained. For babies with a weight less than 1500 g the above relation on the 1 per cent level is also highly significant /$P < 0.01$/. In the case of the weight-group 1500-2499 g the relation

Table 1. Live-births in 1970 by groups of weight and by months

Group of weight	Monthly frequency of births												
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Together
-1499	244	230	267	276	254	240	224	177	226	228	214	215	2795
1500-2499	1148	1135	1329	1264	1323	1180	1092	993	925	951	950	1160	13450
2500-	11013	10958	12641	12080	12607	12055	12337	11635	11072	10005	9033	10131	135567
Total	12405	12323	14237	13620	14184	13475	13653	12805	12223	11184	10197	11506	151812
							Percentage						
-1499	8,73	8,23	9,55	9,87	9,09	8,59	8,01	6,33	8,09	8,16	7,66	7,69	100,0
1500-2499	8,54	8,44	9,88	9,40	9,84	8,77	8,12	7,38	6,88	7,07	7,06	8,62	100,0
2500-	8,12	8,08	9,33	8,92	9,30	8,89	9,10	8,58	8,17	7,38	6,66	7,47	100,0
Total	8,17	8,12	9,38	8,97	9,34	8,88	8,99	8,43	8,05	7,37	6,72	7,58	100,0
-1499	1,97	1,87	1,88	2,03	1,79	1,78	1,64	1,38	1,85	2,04	2,10	1,87	1,84
1500-2499	9,25	9,21	9,33	9,28	9,33	8,76	8,00	7,76	7,57	8,50	9,32	10,08	8,86
2500-	88,78	88,92	88,79	88,69	88,88	89,46	90,36	90,86	90,58	89,46	88,58	88,05	89,30
Total	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00

Figure 1

MONTHLY FREQUENCY OF LIVE-BIRTHS IN 1970 BY GROUPS OF WEIGHT



between the seasonal frequencies of towns and villages is not significant /$P < 0.3$/.

4/ The relation between the seasonal frequencies of the weight-groups of the 1970 live-born has been examined by the type of settlements, too.

In the case of all the births of 1970 and live-births in villages the relation between the seasonal frequencies of the weight-groups, on 1 ‰ level, shows also a very significant value /$P < 0.001$/.

For the live-born of towns the relation between the seasonal frequencies of the various weight-groups, on 1 % level, is also highly significant /$P < 0.01$/. There is no significant relation between the seasonal frequencies of the various weight-groups of the live-born of Budapest /$P < 0.3$/.

5/ The values of the seasonal-indices by the type of settlements.

Studying the seasonal-indices of the live-born of Budapest /Fig. 3/ one can see that in the first season the values of the seasonal-indices in all the three weight-groups are around 110, i.e. the deviations from the mean are +9 - +10 per cent. In the second season the values higher /+3 %/ than the mean can be found only in the case of normal weight, while they deviate from the mean at the weight-group of 1500-2499 g by - 2.5 per cent, and at the weight-group under 1500 g by - 4.5 per cent. In the third season the seasonal-indices of the weight-groups of 2500 g or more, as well as that of 1499-2499 g are 89 and 87 resp.; that means a deviation of 11-13 per cent from the mean. For the weight-group under 1500 g the value of the seasonal index is 102, that means +2 cent deviation from the mean. In the fourth season the seasonal-index of the weight-group 2500 g or more shows a value of about 98.5, what means a deviation of - 1.5 per cent from the mean. The value of the seasonal index of the group 1500-2499 g is 105 with a deviation of +5 per cent from the mean. The seasonal index of the group under 1500 g is 94, thus, its deviation from the mean is - 6 per cent.

The values of the seasonal index of the live-born of towns by groups of weight /Fig. 4/ is as follows:

In all of the three groups of weight one can find the highest values of the seasonal indices in the first season; in the case

Figure 2

SEASONAL-INDICES OF THE LIVE-BORN BY GROUPS OF WEIGHT IN 1970, 1972 AND 1973

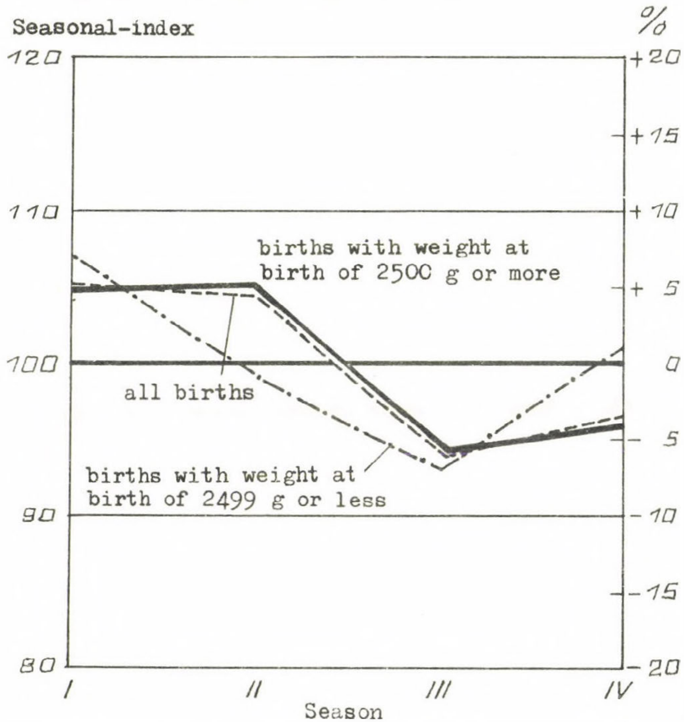
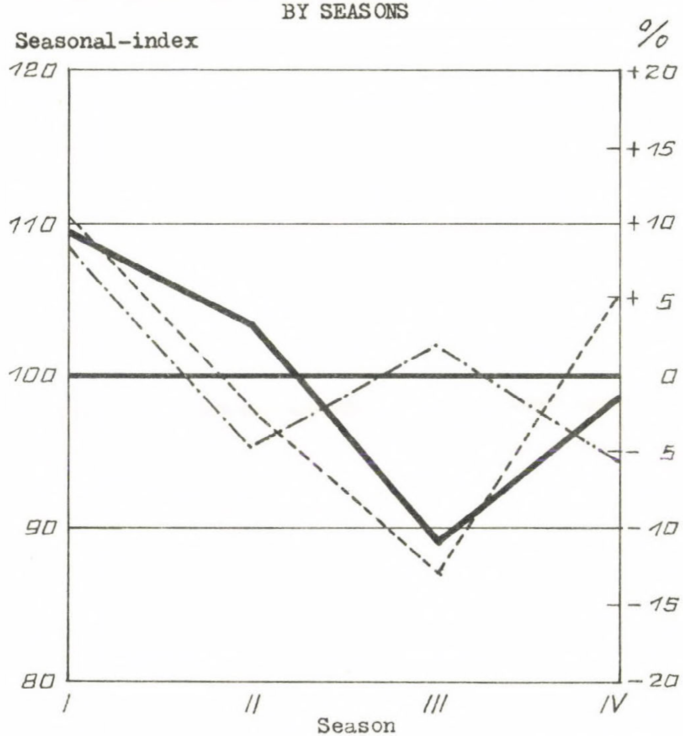


Figure 3

SEASONAL-INDICES OF THE LIVE-BORN OF 1970 IN BUDAPEST, BELONGING TO THE INDIVIDUAL GROUPS OF WEIGHT, BY SEASONS



live-born at birth with a weight of 1499 g or less

live-born at birth with a weight of 1500-2499 g

live-born at birth with a weight of 2500 g or more of those with small weight /1500-2499 g/ 114.5, for those with normal weight/more than 2500 g/ 110.5, and that of very small weight /under 1500 g/ is 111.7; this means +14.5, +10.5 and 11.7 per cent of deviation respectively from the mean.

The second season shows also a rather good similarity to the corresponding season, only the values of the seasonal indices are different. Significant difference can be found in the third season, and there even in the first place in the case of the infants of very small weight: its seasonal index being 97.2 represents a deviation of - 2.8 per cent from the mean.

The value of the seasonal index is 90.6 for those with normal weight, 83.9 for those with small weight, representing - 9.4 and - 16.1 per cent deviation, respectively.

In the fourth season the seasonal index of the babies of small weight - similarly in the same season in Budapest - can be found above the mean with a value of the seasonal index of 103.3 while in the two other weight-groups: the seasonal index of those with normal weight is 94.2 and for those with very small weight is 97.6.

The values of the seasonal indices of the live-born of villages in 1970 by seasons /Fig. 5/ are as follows:

Here too the highest values can be found in the first season: for those of normal weight 110.2 /+10.2 per cent/, for those of small weight 119.3 /+19.3 per cent/ and for those of very small weight 118.1 /+18.1 per cent/.

The seasonal indices of the second season were: for those of normal weight 107.9 /+7.9 per cent/ for those of small weight 96.2/ /- 3.8 per cent/ and for those of very small weight 88.8/- 11.2 per cent/. The difference between the values of the seasonal indices for those of normal - and of very small weight is 19.1 per cent!

In the third season - similarly to the observations at the corresponding groups of the live-born of Budapest and of the towns - the groups of normal - resp. small weight reach their minimal values with the indices of 88 /- 12 per cent/ resp. 83.2 /- 16.8 per cent/, meanwhile the index-value of those with very small weight increases from 88 to 91.6

Figure 4

SEASONAL-INDICES OF THE LIVE-BORN OF 1970 IN TOWNS, BELONGING TO THE INDIVIDUAL GROUPS OF WEIGHT, BY SEASONS

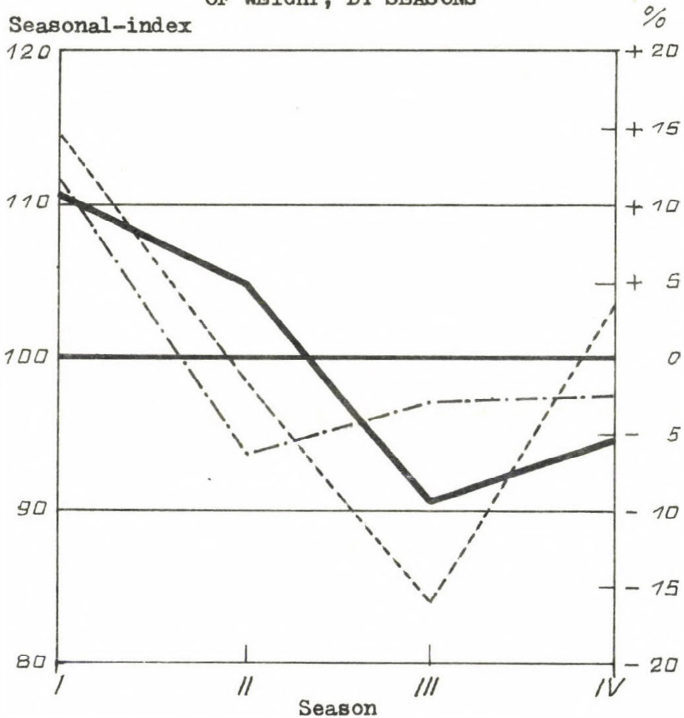
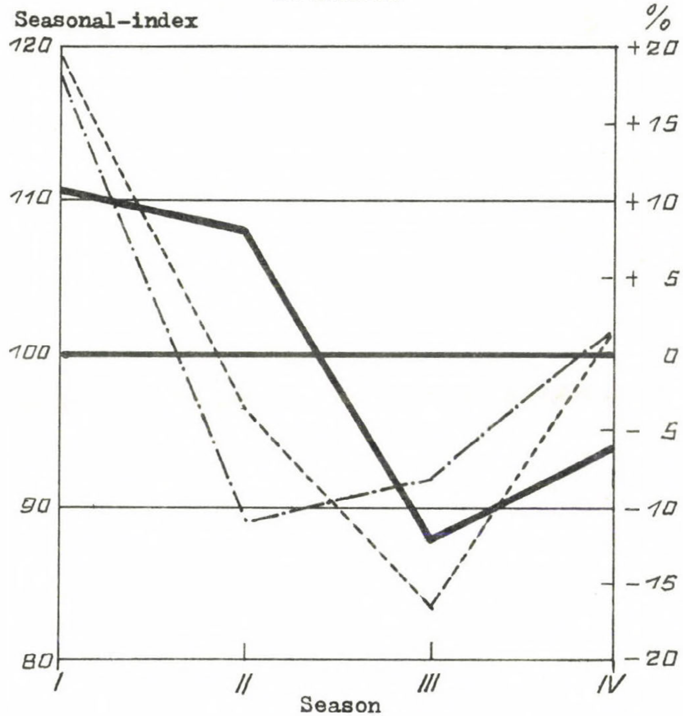


Figure 5

SEASONAL-INDICES OF THE LIVE-BORN OF 1970 IN VILLAGES, BELONGING TO THE INDIVIDUAL GOUPS OF WEIGHT, BY SEASONS



—·—· live-born at birth with a weight of 1499 g or less

- - - - live-born at birth with a weight of 1500–2499 g

▬▬ live-born at birth with a weight of 2500 g or more related to the second season.

The seasonal indices of the fourth season are the following: for normal weight 93.8 /- 6.2 per cent/, sor small weight 101.2 /+1.2 per cent/ and for very small weight 101.2 /+1.2 per cent/. Accordingly, as against the seasonal indices of less than 100, found for the live-born of Budapest and of the towns in the case of very small weight, here the value of the index exceeds 100.

Summary

Studying 151.812 live-born of 1970 seasonal relations have been found between the monthly frequencies of the values of the birth-weight. The seasonal relations in the case of all the births and of those with normal weight between the values of the towns /including Budapest/ and the villages are highly significant /$P < 0.001$/ and in the case of those with very small birth-weight they are significant /$P < 0.01$/.

Investigating the interrelations between the seasonal frequencies of the weight-groups by the type of settlements, highly significant relation /$P < 0.001$/ has been found in the case of all births and of births in villages; for live-born of towns the relation is significant /$P < 0.01$/, while in the case of births in Budapest no significant relation has been found /$P < 0.3$/.

On the basis of the values of the seasonal indices the following main characteristics of the seasonality of the weight-groups can be established: the minimal value for those of very small weight can be found in the second season, on the contrary, the same for those of small and normal weight occurs in the third season.

Based on these findings, definite interrelation can be established between the month of birth and the weight at birth. To analyse the causes of the interrelation is the task of further research.

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THE CHANGING PATTERN OF MENARCHEAL AGE

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By the mid-1950's the main factors that influence menarcheal age were identified, and the effects of several quantitated. Of particular interest was the demonstration that a clear secular trend in this maturational measure had occurred, and its rate had been calculated by Tanner (1955). He showed that in Europe and America the trend to earlier menarche was generally similar, amounting to about 4 months per decade over the period from 1830 onwards. The continuation of this trend was demonstrated by Tanner (1962, 1965) with critical documentation and various factors responsible for it were indicated. To us it seemed impossible that this diminution would continue indefinitely, and therefore that it would be of interest to keep a check on menarcheal age in an attempt to detect the first signs of any slackening of the trend in Britain. To do this thoroughly would necessitate a large-scale expensive investigation, taking the form of a yearly enquiry in a group of schools, questioning girls of age 9-17 years, with subsequent probit analysis of the results. This would be time-consuming, and probably a nuisance to the schools concerned. We felt instead that a small sample enquiry in a particular section of the population would be useful, using an alternative retrospective method of data collection to give recall data from a succession of cross-sectional surveys.

THE LONG-TERM STUDY

In the medical examination carried out at the time of their admission on all girls entering the University College of Swansea from 1959 onwards, the age at birthday preceding menarche was recorded. The 1970 intake was the last to be included in this study, and, with the exception of the 1963 intake for which this item was not recorded, the data are continuous over the twelve years.

Each girl was asked when her menarche had occurred. Such recall data are liable to error or bias from a variety of sources. But such errors are thought to be minimal in the present data, for the sample relates to girls of above average intelligence and reliability of memory, all questioned between the ages of 18 and 21. There was no girl who had not attained menarche at the time of examination. The majority of the girls were quite clear in recalling the actual month, though the data were computed from age at birthday preceding menarche for ease of analysis. The very few girls whose answers indicated that they themselves were in some doubt were excluded from the analysis. Other relevant details were also noted such as the year of birth, the number of siblings the girl has, her numerical position in her sibship, her father's occupation described numerically as in the Registrar-General's classification.

Results: the first seven years

An interim analysis was made at the end of the first seven years (Roberts & Dann, 1967). The menarcheal age showed a clear progressive diminution. There was in addition a slight diminution in family size from which the girls came, and there was a highly significant improvement in the occupational status of the father. There was no consistent trend in position in the family. The menarcheal age by partial regression analysis showed a highly significant association with the number of siblings, and with the position in family, none with father's occupation, and the secular trend (i.e. the regression on year of birth) was highly significant and independent of the other variables.

It seemed then from our data that the secular trend was still continuing, and moreover was compatible with results from other studies from Britain obtained by the status quo method, while our estimate of the rate of secular acceleration (-.058 per year) is not significantly different from the overall figure (-.033) indicated by Tanner for the general trend in European and American data.

Results: the later years

We decided to continue the study for a further five years, and so made our final analysis after the material from the 12th year's intake was to hand (Roberts & Dann, 1975). What a surprise! The results showed no indication of the continuation of the downward trend, but instead they all clustered closely at an intermediate level. There was no longer any significant linear association with year of birth. The slight positive association of menarcheal age with family size and the negative association with position in sibship continued. Father's occupation significantly improved with year of birth, the number of sibs increased, and so also slightly did the position in sibship. There have clearly been important secular social trends during this period. In view of the apparent upturn of the mean menarcheal age, a curvilinear regression was fitted (Figure 1), and when this is done the regression on year of birth becomes significant.

We need to consider the reality of this secular change, to ask whether this apparent end to the downward trend is real, or whether it is attributable to some quirk of the analysis or of the data. From the statistical point of view the downward trend identified in the earlier analysis in the years 1959-65 was highly significant. But this may perhaps have been a statistical artefact, accepted as real because of its similarity to what was expected from published data, or somewhat exaggerated since the first two samples are numerically the smallest. This seems unlikely since there is very close correspondence with results from status quo studies elsewhere in Britain. If that trend is regarded as real, then the curvilinear regression now demonstrated has also to be accepted. If however the earlier trend in the data is not accepted (for the quadratic component in the curvilinear association with year of birth does not reach a very high level of significance) and a linear regression is fitted to the total data instead of a curvilinear, then the secular regression line is nearly horizontal, suggesting again that the downward trend in menarcheal age has ceased.

A second possibility is that the apparent secular association is a reflection of some other variable. There are slight differences in menarcheal age in different geographical areas of Britain; slightly later menarche occurs in north and central Wales, and northern and south-west England, and slightly earlier menarche in south-east England, the midlands, and industrial south Wales. Consistent changes in their representation in the Swansea student intake might produce apparent secular variation. Certainly there occurred a change in the composition of the Swansea sample, for the proportion of girls from south Wales decreased and the proportion from England increased. But calculation of a weighted mean for each year's intake, weighted according to the proportion of girls from each region, shows that differential representation of the regions is not

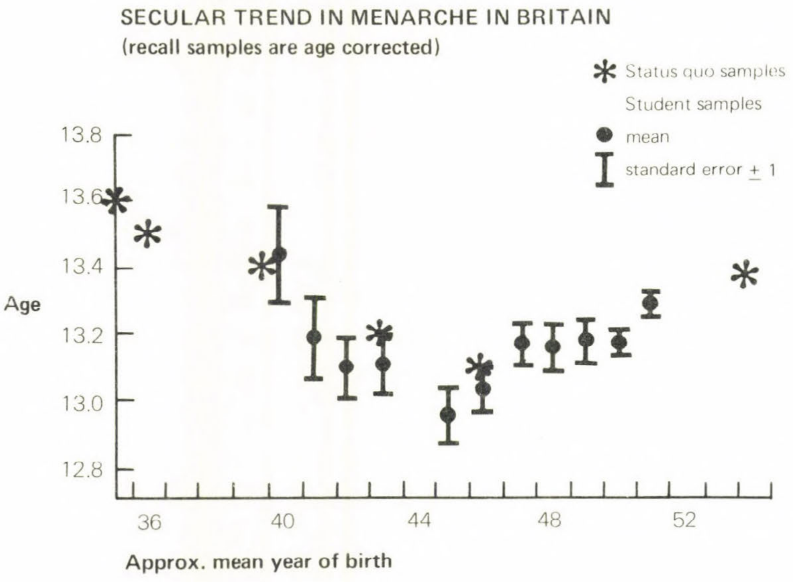

Figure 1

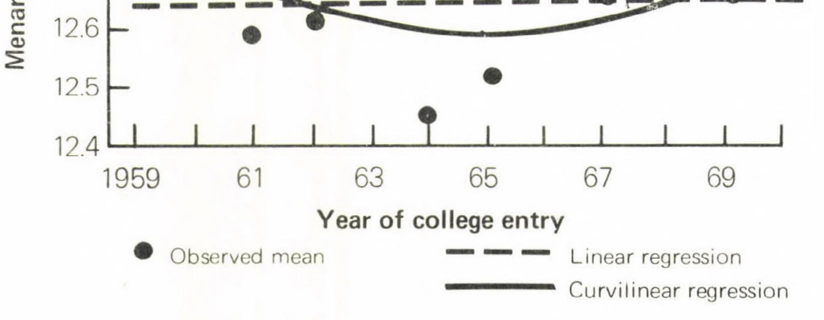

Figure 2

responsible for our overall trend. Similar analysis showed that regional differences in physique and changes in the regional representation in the sample were not responsible for the menarcheal age trend.

We are unable to escape the conclusion that in Britain the downward secular trend in menarche has come to an end, at least temporarily. In the present data it reached its earliest mean in girls born about 1946 (the 1965 student intake) and an upward swing may have occurred since then. This change in the secular trend is not due to the association of menarcheal age with family size or of position in sibship, or to changes in the regional composition of the student intake.

STUDIES IN NORTHERN BRITAIN

A second object of our investigations was to identify sociobiological factors affecting menarcheal age, and we have carried out a number of detailed studies in the north-east of Britain. The first study was made in an industrial urban community, that of South Shields, County Durham, in 1967 (Roberts et al. 1971). Here 1655 subjects were examined in schools of various types; they ranged in age from 9 to 16, all normal schoolgirls of an industrial urban community. These status quo data were analysed by a logistic model. They showed no significant differences between social class; no significant differences whether fathers were unemployed, living apart or dead (i.e. whether families were formally in domestic hardship, requiring considerable social assistance); no differences between schools. They did however show that family size exerts a highly significant effect. But particularly surprising was the result that indicated that the overall median age (13.43 ± 0.05) was later by one-third of a year than that in the last reported sample from Britain. This result is of course compatible with our Swansea 12-year investigation in that it appears to continue the upward trend there demonstrated (Fig. 2). But there are other explanations. For example the sample, drawn from an industrial area where there was still much economic hardship, may have suffered from some environmental retardation of maturation.

We therefore examined a second sample in schoolchildren in south-east Northumberland from middle class suburban areas of Newcastle, in which it was thought that there would be less economic hardship than in South Shields, and this survey was undertaken in the period July 1969 to February 1970 (Roberts et al. 1975). In all, data from 1307 girls were included in the analysis, which was carried out in exactly the same way as for South Shields.

Certainly the Northumberland sample demonstrated the reality of the socioeconomic difference, for the Northumberland sample showed a clear excess of fathers in Registrar-General categories 1, 2 and 3, while the South Shields material showed an excess of categories 4 and 5. But there was no difference in the proportion of families in domestic hardship. However, the two samples differed in family size. The mean family size in the Northumberland sample was 2.99, s.d. 1.42, and in the South Shields sample 3.61, s.d. 2.09. This difference would be expected to act towards earlier menarche in the Northumberland sample, and thus reinforce any difference that might be attributable to socioeconomic differences between localities.

It appeared that the Northumberland menarcheal age results are very similar indeed to those of the South Shields survey, not only in the overall medians (South Shields 13.43 $\pm$ .05, Northumberland 13.31 $\pm$ .03) but also in medians for each family size. Thus for families of increasing size from one to five plus, the South Shields results of 13.04, 13.14, 13.45, 13.68 and 13.66 are very similar to the Northumberland medians of 13.06, 13.13, 13.47, 13.37 and 13.62. The main difference is that in family size 4. The essential similarity between the South Shields and Northumberland medians effectively disposes of the suggestion that the delay in the menarcheal age of South Shields, by one-third of a year by comparison with the last reported status quo sample of Britain, is to be attributed to economic hardship and environmental retardation in the industrial area. But the elevated medians in both samples still do not establish reversal in the secular trend of menarcheal age. It may be that the north-eastern population did not participate in the downward trend to the same extent as elsewhere in Britain, but there is no earlier evidence at all on this. Secondly, they may be genetically distinct from elsewhere in Britain. The results endorse the absence of a social class effect on menarcheal age, parallel to the findings in South Shields, Swansea, and compatible with other studies in Britain; the family size effect again resembles that observed in Swansea and South Shields, not only in its occurrence but also in its magnitude, and this may well represent a direct environmental effect, concealed poverty, acting through nutrition or standards of care.

Overall these findings, from Swansea, South Shields and Northumberland, suggest that environment, particularly in standards of nutrition and general care, is still an important determinant of age at menarche, but today in Britain it operates primarily through family size and no longer through the formerly accepted socioeconomic categories. The Registrar-General's categories today it seems are a less effective index than formerly of differences in housing standards, expenditure on food, and other variables of potential biological relevance. To these instead family size appears to be a much more sensitive indicator, so that poverty that is effective in influencing biological development should perhaps be sought amongst those of large families instead of those of the lower socio-economic categories. Certainly the findings have established the validity of the estimate for current menarcheal age in the north-east. It remains to be seen whether menarcheal age in these areas now remains steady, and whether other regions of the country, particularly where there is some genetic or environmental differentiation, show similar menarcheal age relationships.

STUDIES IN INDIA

It is of course not only in Britain that changes are occurring in menarcheal age. We have recently turned our attention to the changing pattern of menarcheal age in southern India. A primary reason for the limited amount of accurate knowledge of age at menarche in the tropics stems from the uncertainty regarding children's ages. There are however a number of communities in India in which the stages of development are marked by rites of passage of religious significance. Such records have as yet been relatively little utilised in developmental studies, and they provided the basis for our present investigations of menarcheal age in Tamil and Telugu girls.

Three contrasting schools were studied. In Warangal, in Andhra Pradesh, School I (Warangal Junior College) and School II (Warangal School) are similar in that they are day schools, taking in Telugu speakers. This part of Andhra is not well developed, and the population remains generally of low socioeconomic status; Warangal town, with a population of approximately 200,000, is more semiurban than urban. The Warangal school-children are poorer than those in the Junior College, since the school caters for the poorest section of the community. By contrast, pupils in School III in Madras are from the richer socioeconomic stratum of society there, for it is a private school charging a comparatively high fee. The families to which they belong are Tamil speaking, and should be regarded as representing a separate population of good socioeconomic status. To these data we applied a logit analysis. The results show that the differences between the schools in median age at menarche correspond well with the socioeconomic differences between them. In the most advantaged school (School III) the median age was 12.86 with 95% fiducial limits of 12.65 to 13.07. The poorest (School II) had a median age of 14.08, with 95% fiducial limits 13.69 to 14.43, while the intermediate school I had a median age of 13.74, 95% limits 13.53 to 13.96. The results in the intermediate school compare with a previous study in a Madras school of intermediate economic status, which showed a median of 13.69 years, confidence limits 13.47 to 13.92 (Singh & Roberts, 1975).

It is of interest that the median age in the most advanced school is comparable with that in some recent studies in Europe. Comparison of the other data that are available from elsewhere in southern Asia show similar socioeconomic gradations. It appears that with the increasing living standards that accompany socioeconomic advancement there comes a diminution in menarcheal age, and this is just as important a component of the changing pattern of menarche as the secular trend that we have studied in Britain.

CONCLUSION

Menarcheal age is a strictly biological variable affected both by biological and social factors. From the present studies it appears indeed to be a particularly sensitive indicator of sociobiological status. Not only does it show quite gross differences when there are major variations in socioeconomic status as seen in the Indian results reported here, but also it responds by minor changes to quite minute variations in the environment, as in the family size effect in the British studies. To disentangle the complex web of interrelated factors that affect mean menarcheal age is difficult, but the present studies show how useful is a continuing study, to monitor slight year to year changes that individually would be undetectable but become apparent over a period. For though the detailed causes of such changes may remain obscure, their gross effects are sufficiently clear to show whether there is need for concern. Ongoing studies of menarcheal age thus provide a useful index of the biological status for the population.

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RECENT DATA TO THE PHYSICAL DEVELOPMENT OF ADOLESCENT GIRLS

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Abstract

In a sample including 1093 girls 10.0 - 15.0 years of age from Székesfehérvár belonging to the same age-group the author compared the physical development of already menstruating and not yet menstruating girls. She demonstrated and statistically proved that the weight, stature, shoulder-, bicristal- and thoracal widths, the chest depth, as well as the chest-, upper arm-, thigh- and lower leg circumferences of the girls who have reached maturity at an earlier time significantly surpassed those of the not yet mentsruating girls. Further, she examined the correlation of the physique with age at menarche, and found that the first menstruation ensues earlier with the buxom, more robust girls than with the rather little ones.

Introduction

In the literature on the ontogenesis of adolescents the number of examinations of the endogenous and exogenous factors affecting somatic development is quite considerable. In spite of the great number of studies of this kind, information on the connection of the increase of the various body measurements, of the formation of the body proportions with the time of the onset of sexual maturation is rather scarce.

It is a known fact the younger the age at which sexual maturation takes place, the more marked is the puberal growth spurt ensuing in the various body measurements, since with those reaching puberty earlier, the growth processes become more intense, they come about and, therefore, end sooner. The examinations conducted so far have demostrated differences in the physique of the girls of later and earlier maturation. According to the results of Kralj-Čerček's /1956/ examination, who differentiated three types of physique in girls: the Gothic, the Baroque and the Renaissance types, the menarche of the Baroque type took place at the earliest time, and those of little body construction of the Gothic type began to menstruate last. Tanner /1955/, who examined the connection of Sheldon's morphological types with the time of menarche, found that the girls of endomorphous physique reached maturity earlier than the ectomorphous ones.

The simultaneous studies of the body measurements and the time when maturity appears do not present such an unambiguous picture. While according to Boas /1897/ and Tanner /1955/ menarche ensues sooner with girls of taller stature and heavier weight. Corrain /1956/ found in the course of his examinations that with the girls who grew more rapidly and taller, sexual maturation was delayed: the first menses of those of lower and medium statures took place earlier. Grzesicka /1962/ found in an examination conducted in Poznan girls, that the sexual maturation of the ones of taller stature and heavier weight set in later than that of the lower and less heavy ones. Also the trends of other measurements were examined besides stature and weight, in their relationship with the age at menarche; thus e.g. Bayley /1943/ found that the girls having wilder shoulders matured later. On the other hand, Malinowski and Pawlaczyk /1967-68/ have proved that those beginning to menstruate at earlier ages surpassed those reaching maturity later also in the width of the hips and chest besides shoulder width.

The examinations enumerated above, which conduced to contrary results, have raised the idea of examining whether in the measurements of already menstruating and not yet menstruating girls of the same age-group a significant quantitative difference could be demonstrated, and whether there was a difference in the absolute measurements and whether this meant that also the difference in the physique of the girls having reached puberty at diverse times was significant.

Material and method

The author conducted a general and special survey of data regarding the age at menarche by means of questionnaires in the county Fejér in 1972. The survey was completed by an anthropometric examination of girls in the town of Székesfehérvár. The data collected in the county Fejér were elaborated in several respects and also published in part /Bodzsár 1973, 1974/. At the anthropometric examination 21 measurements of 1093 10.0 - 15.0 years old girls were taken with Martin's technique. So that the dimensions of the body may be compared, the author calculated, among others, the values of Rohrer's fullness index, Kaup's index of physique, Piaget-Vervaek's index of robusticity and Rohrer's index of the state of nutrition. Rohrer's index expresses weight /g/ in per cent of the cube of the stature /cm/; Kaup's index, again, is the ratio of weight /g/ and the square of stature /cm/. The robusticity index indicates the value of the sum of weight /kg/ and chest circumference /cm/ expressed in per cent of the stature /cm/; and the nutritional index indicates weight /g/ in per cent of the product of the multiplication of the stature /cm/, shoulder width /cm/ and depth of chest /cm/.

Having arranged the surveyed data in half-yearly age-groups /Table 1./, for each character the usual statistical parameters were calculated in each of the groups /non-menstruating, menstruating, the two together/. The measured and the calculated characters of the menstruating and not yet menstruating girls of identical age were compared by means of Student--Fischer's two-sample t-test. For significance level the author took the generally accepted value of 5%.

Table 1

Distribution of Székesfehérvár girls after age and menarche

Age /yr./	Non-menarcheal	Menarcheal	Together
10,0	6	-	6
10,5	26	-	26
11,0	65	2	67
11,5	81	17	98
12,0	112	56	168
12,5	93	80	173
13,0	62	116	178
13,5	33	130	163
14,0	9	109	118
14,5	9	73	82
15,0	1	13	14
Together	497	596	1093

Results of the examination and their evaluation

In the present paper the author intends to discuss the results she obtained relying on indices which better reflect physique than the absolute measurements; but first she gives a brief summary of her partly already published results /Bodzsár 1975/ achieved relying upon certain measurements of major importance.

As to the measurements of length, author found that in absolute value the means of the already menstruating girls examined by her surpassed those of the not yet menstruating girls of the same age. This difference is of the highest significance in the stature, still - excepting one or two age-groups - it is not significant with the lengths of the extremities. The trends of the differences in the stature and/ or in the lower extremity length of the already menstruating end not yet menstruating girls permit the conclusion that with the relatively "long-legged" girls the first menses ensue at older ages.

Out of the measurements of width the author examined the shoulder width, bicristal width, chest width, as well as chest depth, and could state unambiguously that also in these measurements the already menstruating girls surpassed the not yet menstruating ones.

The measurements of circumference afford useful information on the masses of the trunk and extremities, on the development of the muscles of the extremities, and therefore they had to be taken by all means on the occasion of the morphological examination. All measurements of circumference /chest circumference in a state of rest, upper arm-, thigh-, lower leg circumference/ examined by the author in the already menstruating girls by far surpass the measurements of the girls of identical age who do not yet menstruate; the differences are significant on a very high level. The mean value of all measurement of circumference of the 11.5 years old already menstruating girls surpasses the ones of the not yet menstruating 14.5 years old girls.

Within the same age-group, the difference in weight of the menstruating and not yet menstruating girls is highly significant; the differences between their means vary between 5.42 - 9.20 kg., the levels of significance are very high /$P < 0.1. - 0.5\%$/.

Out of the indices expressing the proportion of weight and stature the author calculated Kaup's morphological and Rohrer's fullness indices. In spite of the fact, that according to the fidings of the examinations conducted up to now, it is a deficiency of Rohrer's index that the weight does not grow proportionately to the cube of the stature, the author found that, similarly to Kaup's index, the variation of Rohrer's index as calculated in her examinations accurately followed the rate of growth of the stature and weight with the advance in age. However, she would like to observe, that the responsivity of Rohrer's index is lower than the one of Kaup's index.

In each of the age-groups the mean values of Kaup's and Rohrer's indices found with the already menstruating girls are lower than those of the not yet menstruating ones. With Rohrer's index this difference amounts to 0.1 - 5.0% and with Kaup's index to 0.5 - 0.1%, the latter being significant on a very high level. The trend of the mean values of these two indices shows that among the girls of identical age those of lower stature and less weight reach maturity later /Tables 2 and 3 /.

Piaget-Vervaek's robusticity- and Rohrer's state of nutrition indices serve for characterizing the physique and include several absolute measurements. With minor fluctuations, the index of robusticity significantly increases with advancing age /Table 4 /. Hence it follows that during pubescence the physique of the girls becomes gradually wider. The mean value of the index increases from 70.39 to 81.50 in the examined age interval. The intensity of the increase is greater between the ages of 10.0 and 13.0 years. Comparing the mean values of the indices of the already menstruating and not yet menstruating girls of the same age rather significant differences /$P < 0.1 - 2.0\%$/ can be observed to the advantage of the already menstruating girls. The mean of the robusticity index in the 14.5 years old age-group of the non-menstruating girls does not even attain that of the 11.0 years old already menstruating ones. Founded on the means of the robusticity index, it can be stated unambiguously that the physique of the girls menstruating raletively earlier is more stocky.

The difference between the means of the nutritional indices of the already menstruating and not yet menstruating girls of identical age is significant up to the age of 13.0 years; the index values of the older age-groups are though higher among the already menstruating girls, but not on a significant level /Table 5 /. It can be observed, further, that with advancig age the means of the values of the nutritional indeces of the non-menstruating girls decrease; consequently, taking into consideration a latest possible age at which the first menses have not yet ensued, it becomes

Table 2

Kaup's index of physique

Non-menarcheal				Menarcheal						Together		
$\bar{x}$	$\pm s_{\bar{x}}$	s	$V_{min}-V_{max}$	$\bar{x}$	$\pm s_{\bar{x}}$	s	$V_{min}-V_{max}$	t=	p	$\bar{x}$	$\pm s_{\bar{x}}$	s
1,69	0,15	0,36	1,39-2,35							1,69	0,15	0,36
1,71	0,07	0,33	1,08-2,32							1,71	0,07	0,33
1,70	0,03	0,27	1,36-2,41	1,77	0,06	0,09	1,71-1,83			1,70	0,03	0,27
1,74	0,02	0,23	1,30-2,49	2,06	0,08	0,34	1,67-2,70	4,827	0,001	1,80	0,03	0,27
1,68	0,02	0,23	1,27-2,41	1,90	0,04	0,29	1,52-2,79	5,276	0,001	1,75	0,02	0,27
1,73	0,03	0,29	1,31-3,21	1,94	0,03	0,28	1,58-2,88	4,883	0,001	1,83	0,02	0,30
1,70	0,03	0,27	1,25-2,77	1,94	0,03	0,29	1,44-2,90	5,391	0,001	1,85	0,02	0,31
1,73	0,05	0,28	1,38-2,88	1,88	0,02	0,26	1,40-2,99	2,972	0,005	1,85	0,02	0,27
1,68	0,04	0,11	1,52-1,89	1,89	0,02	0,20	1,50-2,44	3,131	0,005	1,88	0,02	0,20
1,70	0,04	0,11	1,53-1,92	1,96	0,03	0,28	1,27-2,66	2,742	0,001	1,93	0,03	0,28
				1,97	0,11	0,38	1,60-3,03			1,94	0,10	0,38

Table 3

Rohrer's fullness index

Non-menarcheal				Menarcheal						Together		
$\bar{x}$	$\pm s_{\bar{x}}$	s	$V_{min}-V_{max}$	$\bar{x}$	$\pm s_{\bar{x}}$	s	$V_{min}-V_{max}$	$t=$	p	$\bar{x}$	$\pm s_{\bar{x}}$	s
1,23	0,12	0,30	1,00-1,80							1,23	0,12	0,30
1,23	0,05	0,24	0,71-1,65							1,23	0,05	0,24
1,19	0,02	0,20	0,94-1,77	1,20	0,00	0,00	1,20-1,20			1,19	0,02	0,19
1,18	0,02	0,14	0,92-1,60	1,36	0,06	0,26	1,10-2,05	4,132	0,001	1,21	0,02	0,18
1,13	0,01	0,16	0,82-1,63	1,22	0,02	0,19	0,90-1,86	3,210	0,005	1,16	0,01	0,17
1,14	0,02	0,19	0,89-2,14	1,24	0,02	0,19	0,97-1,82	3,377	0,005	1,19	0,02	0,19
1,11	0,02	0,17	0,85-1,72	1,24	0,02	0,19	0,90-1,84	4,331	0,001	1,19	0,01	0,19
1,12	0,03	0,19	0,84-1,82	1,20	0,01	0,17	0,86-1,91	2,191	0,050	1,18	0,01	0,18
1,09	0,04	0,13	0,97-1,41	1,20	0,01	0,14	0,94-1,57	2,380	0,050	1,19	0,01	0,14
1,10	0,02	0,08	1,00-1,19	1,23	0,02	0,18	0,80-1,67	2,404	0,050	1,22	0,02	0,18
				1,24	0,06	0,22	0,96-1,85			1,22	0,06	0,22

Table 4

Piaget-Vervaek's index of robusticity

Non-menarcheal				Menarcheal						Together		
$\bar{x}$	$\pm s_{\bar{x}}$	s	$V_{min}-V_{max}$	$\bar{x}$	$\pm s_{\bar{x}}$	s	$V_{min}-V_{max}$	t=	p	$\bar{x}$	$\pm s_{\bar{x}}$	s
70,39	2,66	6,51	62,64-78,21							70,39	2,66	6,51
73,93	1,86	9,47	57,53-90,63							73,93	1,86	9,47
72,65	0,92	7,42	61,52-96,33	75,81	2,32	3,28	73,49-78,13			72,74	0,90	7,34
74,49	0,73	6,59	61,88-99,16	82,81	1,97	8,13	71,71-95,50	4,533	0,001	75,93	0,76	7,54
72,72	0,54	5,76	63,38-92.49	79,55	1,09	8,16	68,11-105,32	6,272	0,001	75,00	0,57	7,37
74,46	0,78	7,55	63,03-108,08	80,68	0,87	7,82	70,20-108,15	5,315	0,001	77,34	0,63	8,26
73,83	0,45	7,45	60,42-106,01	80,81	0,74	8,01	67,11-107,86	5,675	0,001	78,38	0,64	8,48
74,82	1,43	8,24	64,45-108,73	79,66	0,64	7,26	64,50-110,62	3,324	0,005	78,68	0,60	7,70
74,63	0,92	2,77	71,97-80,00	79,84	0,54	5,66	68,18-94,71	2,726	0,010	79,44	0,52	5,66
74,89	0,79	2,37	72,05.79,16	81,67	0,90	7,70	61,29-103,69	2,615	0,020	80,93	0,84	7,60
				82,06	2,81	10,13	72,60-110,64			81,50	2,66	9,96

Table 5

Rohrer's index of the state of nutrition

Non-menarcheal				Menarcheal						Together		
$\bar{x}$	$\pm s_{\bar{x}}$	s	$V_{min}-V_{max}$	$\bar{x}$	$\pm s_{\bar{x}}$	s	$V_{min}-V_{max}$	t=	p	$\bar{x}$	$\pm s_{\bar{x}}$	s
39,49	3,60	8,81	33,49-57,16							39,49	3,60	8,81
36,44	0,93	4,75	27,31-45,40							36,44	0,93	4,75
36,40	0,56	4,58	25,08-50,17	37,34	0,65	0,92	36,69-38,00			36,43	0,55	4,51
36,09	0,43	3,88	25,35-46,77	38,96	1,02	4,22	34,23-50,32	2,721	0,010	36,59	0,41	4,07
35,45	0,37	3,97	25,05-46,11	36,80	0,55	4,14	29,96-47,00	2,048	0,050	35,90	0,31	4,07
35,08	0,46	4,47	28,42-55,66	36,94	0,44	3,93	30,21-47,61	2,874	0,005	35,94	0,32	4,32
35,02	0,50	3,97	26,26-44,54	36,60	0,36	3,97	25,72-50,56	2,522	0,020	36,05	0,30	4,03
34,97	0,62	3,56	29,48-42,86	35,71	0,35	4,04	28,31-49,58	0,960	0,400	35,56	0,30	3,95
31,95	0,97	2,92	28,53-38,09	35,84	0,37	3,93	28,89-54,94	2,897	0,005	35,55	0,36	3,99
34,83	0,80	2,42	30,21-37,32	36,45	0,43	3,75	29,83-47,39	1,258	0,300	36,27	0,40	3,65
				36,81	1,39	5,04	30,71-45,70			36,49	1,33	4,99

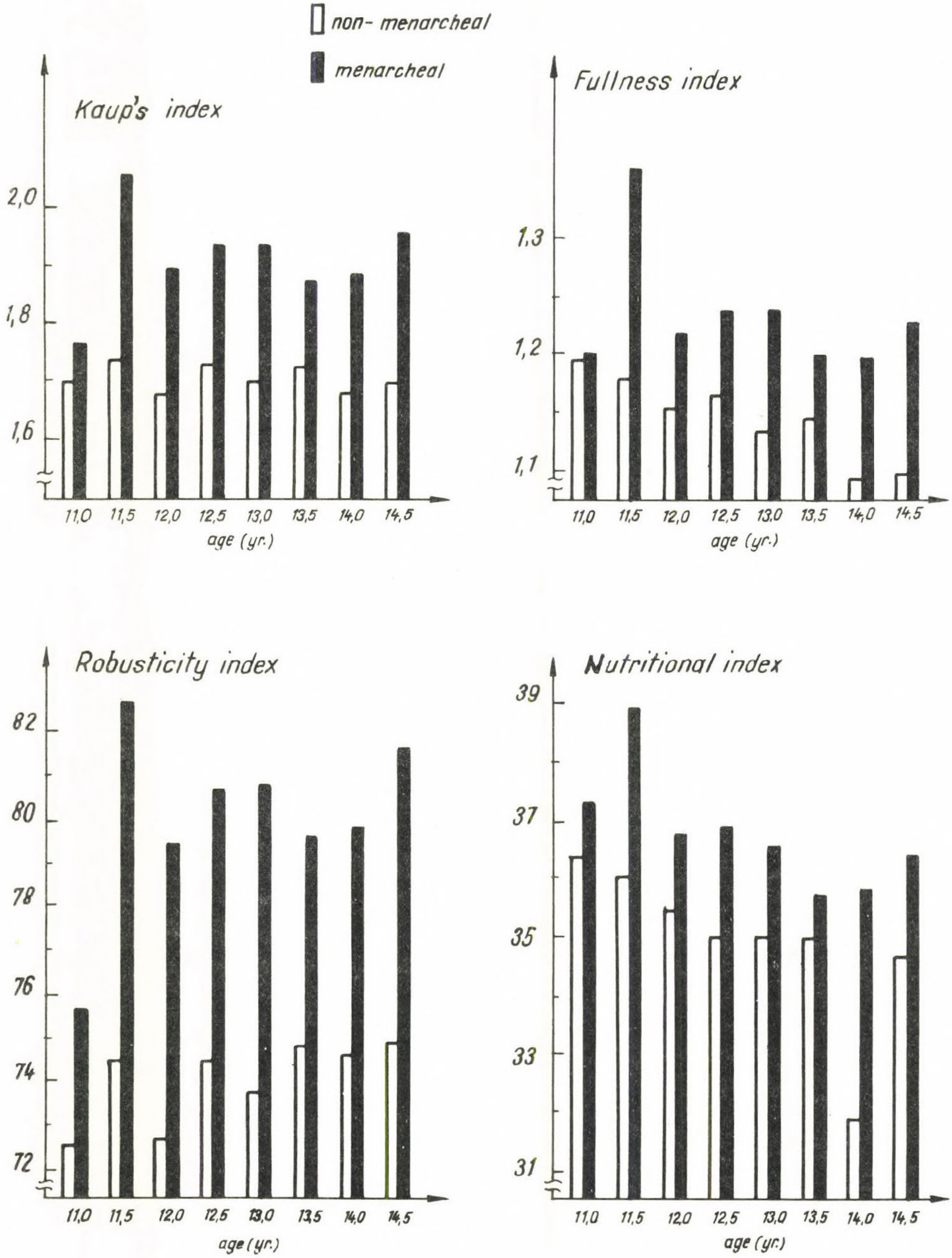
non- menarcheal
menarcheal
Kaup's index
2,0
1,8
1,6
11,0 11,5 12,0 12,5 13,0 13,5 14,0 14,5
age (yr.)
Fullness index
1,3
1,2
1,1
11,0 11,5 12,0 12,5 13,0 13,5 14,0 14,5
age (yr.)
Robusticity index
82
80
78
76
74
72
11,0 11,5 12,0 12,5 13,0 13,5 14,0 14,5
age (yr.)
Nutritional index
39
37
35
33
31
11,0 11,5 12,0 12,5 13,0 13,5 14,0 14,5
age (yr.)

Fig. 1.

more and more conspicuous that the girls maturing relatively later are of "slim" physique. On the other hand, from the trend of the values of the nutritional index by age-groups of the already menstruating girls one can conclude that those reaching maturity earlier are of a "fuller" physique and better fed, further it can also be stated that the later menarche ensues in their ages, the more slender is the physique of the girls. This explains why from the age of 13.5 years on there is no significant difference between the mean values of the nutritional indices of the already mature and not yet mature girls.

By way of a summary one can state that the physique of the girls coming to maturity earlier substantially differs from the one of those maturing at a later time; the lither their build, the later the first menstruation sets in with them.

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ANALYSIS OF MENARCHE AND GYNAECOLOGICAL WELFARE OF BUDAPEST SCHOOLGIRLS

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INTRODUCTION, MATERIAL AND METHOD

This study investigates the exact date of menarche in 5338 Budapest schoolgirls, all had been patients of pediatric gynaecological outpatient department of Heim Pál Children's Hospital during the years of 1966-1975. In all respect, the manner of examination was always the same. In each case the bimanual gynaecological observation was followed by mincrobiological culture methods, blood serum analysis for haematologic and allergic purposes as well as hormonal investigation. According to disorders the girls segregated into two groups: those who had menstrual irregularities, and those who had not. The distribution of hormonally disturbed /2592 girls. 48.5%/ and hormonally intact patients /2746 girls, 51.5%/ was approximately equal. The evaluation of these data was performed by the use of computer. In accordance of 1916 cases, the mother's menarcheal data were also registered with a similar accuracy but without gynaecological examinations.

RESULTS

Among the menstrual irregularities juvenile metropathy was observed in 267 cases /10.3%/, pollakymenorrhoea in 314 girls /12.1%/, polymenorrhoea in 206 patients /7.9%/, while in a moderate number hypermenorrhoea in 113 girls /4.36%/. True precocious puberty was found to be extremely rare, it was diagnosed in sixteen patients only /0.61%/. From the hypofunctional uterine bleedings raromenorrhoea was the most numerous /921 patients /35.5%/. Amenorrhoea secundaria was diagnosed in cases where the menstruation ceased at least 12 months, there were 110 amenorrhoic girls /4.2%/. Cycle disbalance has been found in 22 girls

/0.8%/. Primary and secondary dysmenorrhoea formed an imposing group with 599 patients /23.1%/, while premenstrual tension was present only in 24 girls /0.1%/.

The following tendency was observed for the association of different disorders: dysmenorrhoea joined mainly to raromenorrhoea /64 cases: 10.7%/, to retroflexio-versio uteri /22 cases: 4.1%/ to obesity /17 cases: 2.9%/. Raromenorrhoea was observed together with obesity in 62 cases /6.8%/, with hypertrichosis in 19 cases /2.1%/. Since the upper age limit of patients is 18 years, it can be stated that this study reflects and analyses the history of Hungarian girls' postmenarcheal maturation.

Within the first 6 month after the onset of menarche, 162 girls were examined /3.0%/. Of these 83 girls had no hormonal problems /51.2%/, the remainder suffered from raromenorrhoea /17 cases: 10.5%/, from polymenorrhoea /12 cases: 7.4%/, from pollakymenorrhoea /10 cases: 6.1%/ from juvenile metropathy /4 cases: 2.5%/, from hypermenorrhoea /2 cases: 1.3%/, from cycle dysbalance /6 cases: 3.7%/, from dysmenorrhoea /6 cases: 3.7%/. Adnexitis unilateralis was diagnosed in 6 patients /3.7%/ and parametritis in 6 cases /3.7%/, while obesity in 10 cases /6.1%/. The preponderance of hormon-related diseases could not be demonstrated neither in this postmenarcheal group nor in all girls studied according to the early onset of menarche /under 10 years old/.

Among hormonally intact girls vaginal mycosis was seen in 364 cases /13.2%/, trichomenadosis in 281 cases /10.2%/, enterobiosis in 291 cases /10.6%/ and sexually transmitted gonorrhoea in 5 cases /0.2%/. It is worthwile to emphasise that, except the gonorrhoea, our patients were mostly infected asexually. There were only 455 /3.0%/ in my whole patientmaterial of 15 108 young girls who had sexual experience and conducted sexual life. Collecting data of their sexual comportment, 223 girls /73.4%/ had a constant partner with regular sexual activity /weekly: 49%/, while 119 had irregular sexual contacts /monthly: 26.1%/. After rape I have seen 8 patients /1.8%/, and 112 /24.5%/ after defloration. Studiing the contraceptive methods used by both, it became clear that among the girls only a few tried to use some protections /48 girls: 10.5%/, among the men the most usual method was coitus interruptus /203 men: 44.6%/, and only 20 couples /4.4%/ made efforts to simultaneous contraception. In this sexually active group, 82 pregnancies /18.0%/ were observed mostly interrupted artificially.

Adnexitis occurred in 39 girls /8.6%/, with sexual activity, but it was observed in 94 persons without sexual life, mostly concomittant to appendicitis /29 cases: 30.9%/. Parametritis was demonstrated in 24 girls. A total of 6 ovarian cysts were found without malignancy.

Obesity affected 292 girls /5.5%/ and there was a great difference in distribution for hormonally intacts /125 girls: 42.8%/ and hormonally disturbed patients /167 cases: 57.2%/.

The mean menarcheal age for hormon-disturbed patients was calculated by a computer to be 12 years 3.9 months with a variation up to 14.9 months. The same age for hormonally intacts became 12 years 5 months, variation up to 14.3 months. With a statistical security of 95%, it was proved that the difference of these two curves is statistically significant t = 2.620. The mean menarcheal age for mothers is given in 13 years 6.5 months with a variation up to 26 months. In analyzing the onset of menarche whether it coincided with the birthday of patient or not, it was found for mothers in 8.34%, for girls in 3.45% and only in 0.60% for mother-daughter pairs.

DISCUSSION

This study differs from other menarche-concerning observations in that respect, that these data were collected during 10 years from a highly selected gynaecologically disturbed population, it is from menstruating girls with different types of genital disorders. My data were not apt to be elaborated by the method of probit analysis as it was done by Eiben /1968, 1970, 1972/ in 15.229 girls, age between 11.5-16.0 years. Later Bodzsár /1975/ studied this question in 8.133 girls age between 10.5-15.5 years. In Hungary similar investigations were published by Farkas /1962, 1963, 1964/ and Véli /1968, 1971/. In analyzing my data, it can be seen that among already menstruating Budapest schoolgirls there is a statistically significant difference in the onset of menarche for hormonally intacts and for hormonally disturbed patients. This difference is not based on the percentage of early menarche onset /up to ten years of age/. Otherwise, the occuring gynaecologic diseases are not very serious, mostly asexually transmitted genital inflammations of external and internal genital organs, which diseases can be quickly cured. It has been concluded that our menstruating Budapest girls affected by some gynaecologic disorders during the last decade /1966-1976/ form genetically and physically a healthy population in accordance with the higher post-war socio-economic standard of life.

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ENDOCRINE AND SOMATIC BACKGROUND OF THE PERIMENARCHE

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ABSTRACT

The endorcine and somatic background of menarche, the highly important "meeting-point" of the changes taking place in pubescence has been investigated by the authors. From among the somatic data body weight and height, the degree of maturity of the secondary sex characteristics were investigated at the time of menarche. Evaluation was performed on the basis of an elaborated point system according to the degree of maturity of the breasts, uterus, pubic and axillary hairs as well as on the grounds of the hormone-cytologic appearance. The signs characteristic of early childhood were denoted, in every case, by zero, those characteristic of the mature female by 4 points. Thus, on the grounds of the selected 5 criteria of the investigations, the mature, normally developed female attained a number of 20 points, the small child 0 point. Menarche occurred around the average value of 13 points. The authors utilized their observations in the prediction of the probable time of menarche. Hormone assays were made with the method in cases when menarche was soon to be expected. In this way there was a higher possibility of obtaining data on the sex-endocrine activity directly prior to the menarche. By means of radioimmune-assay the FSH-LH-oestradiol-progesteron levels were determined. The evaluation of these latter is under way. In the series of hormone-cytological investigations with the point system there were 3 cases in which ovulation preceding the menarche was prowed. The data justify the existence of a dynamic interaction prior to the menarche.

INTRODUCTION

The transitional period between childhood and adulthood, the period of puberty, is characterized by well-traceable changes that make the sexual differentiation between male and female complete. The organs important in reproduction show a great degree of growth and begin their cyclic functions characteristic of the age of sexual maturity /Dewhurst 1969, Jenner et al. 1972, Tanner 1974, Zacharias et al 1970/. In additio to all this, marked psychical changes are taking place.

The age of puberty is of special importance for the individual. The appearance of the menarche involves not only psychical changes. At this "junction point", in the perimenarche, the neuroendocrine disorders may also be manifested increasingly in a similar way as in the climacteric.

As to the neuroendocrine regulation of puberty a lot of questions are still open. These are partly due to methodical reasons, partly to the fact that this period of life is just beginning to come into the focus of attention. The knowledge of the physiology and pathology of adolescence is important not only for the given age group. The first signs of pathologic processes that will fully emerge later may appear first at this time.

Thus, all data related to puberty and to the period of the perimenarche may be very valuable.

The occurrence of the menarche fluctuates within a rather wide range /Widholm, Kantero 1971, Zacharias et al 1969/. It is regarded normal between 9 and 16 years of age. Its date of appearance shows a forward trend all over the world. In the last 100 years it is coming forward at a rate of four months every ten years, on the average /Baanders-van Halevijn, de Waard 1969, Bottyán et al. 1963, Eiben 1972, Tanner 1962, Véli 1971/.

Views on the menarche are divided. According to a previous opinion, the first bleeding is always anovulatory, or it was even held that in the 2-3-year period following the menarche ovulation was always absent. This was called the "adolescent sterility interval" /Cooperman 1949, Dewhurst et al. 1971, Doring 1963/. Today an increasingly growing number of researchers have proved that ovulation can take place during the menarche and a certain proportion of the subsequent cycles is also ovulatory /Borsos et al. 1971, Borsos et al. 1975, Borsos, Veres 1976, Widholm, Kantero 1974, Winter, Faiman 1973/. It is not easy to give an unequivocal answer to the question, in fact, a very great number of examinations ought to be performed in the adolescent age group to involve the period directly prior to the menarche.

One of the main aims of our investigations was to elaborate a metho for a possibly exact determination of the expectable occurrence of the menarche, then, by the help of the method, to obtain data on the endocrine and somatic changes in the premenarchal period.

MATERIAL AND METHOD

In the pediatric gynecological consultations at our Department, from among the patients such girls were selected, with a previously elaborated point-system of evaluation, who complained of an increased amount of not infectious adolescent discharge and in whom no disorder was found. The menarche in these patients occurred within 8 weeks prior to the examination.

Since the beginning of the investigations 32 girl patients have been found suitable for observation. First the body weight and height were determined. On the basis of the maturity of the breasts, the pubic and axillary hairs, the proportion of the uterus and according to the hormone-cytological appearance the points shown in Fig. 1 were given to each person. Adding up these points the girls under examination were characterized by a single number.

The above-mentioned number was used to select the bealthy girls whose menarche was shortly to be expected. Series of hormone-cytological assays were performed on these 24 patients. In five cases plasma estradiol, progesterone, FSH-LH level determinations were carried out with radioimmunoassay. The collection of the material is in progress.

RESULTS

In the course of the examinations, at the occurrence of the menarche the body weight was found to be an average of 45.8 kg, with the extreme values of 35.6 and 56 kg. The average body height was 153.6 cm with the extreme values of 144 and 164 cm.

On examining the maturity of the breasts at the date of the menarche the maturity of stage 3 was the most frequent /with the nipple projected, the areola pigmented, and with a separation of contours between the areola and the rest of the breast/. Stage 4 was not attained by any of the girls examined. On the other hand, the menarche occurred only in 6 cases at stage 2.

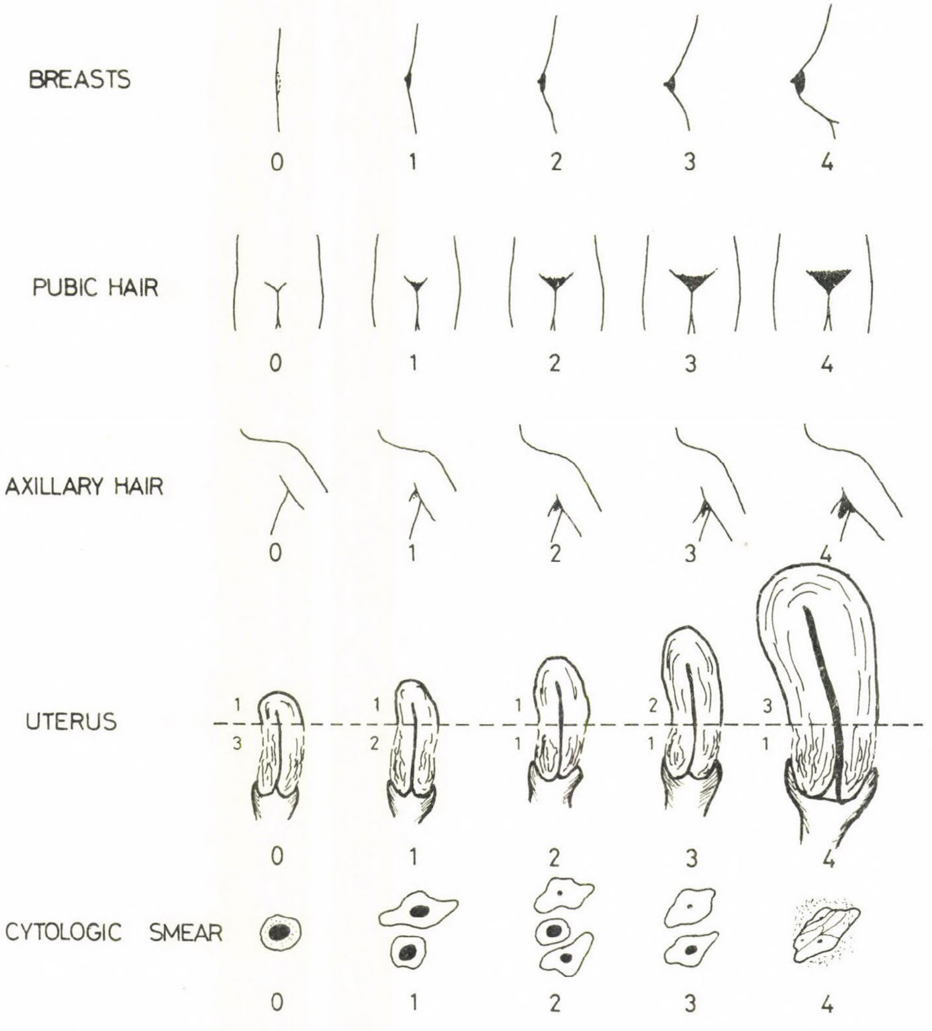

Fig. 1 The point system according to the degree of maturity of the breasts, pubic and axillary hairs, uterus, as well as on the grounds of the hormone-cytologic appearance

The pubic hairs were found in the stage of development denoted by 2. In a few cases the menarche occurred a stage 1, and only in 3 cases did the pubic hairs attain stage 3.

In the examination of the uterus the corpus-cervix ratio was taken into consideration. This was most frequently 2:1 during the menarche. Only in two cases did the menarche occur in stage 2, and in none of the cases did the patients reach stage 4.

In the hormone-cytological examinations stage 3 was found with the highest frequency. This meant the registration of a kind of cyclicity. The proportion of superficial cells was sometimes higher, sometimes lower. After the menarche cyclicity was not in all cases as regular as it was in the cycles of full value. It was sometimes shorter, sometimes longer than 28 days. There may be a considerable deviation from this. With the help of the point-system of evaluation in 3 cases ovulation was justified immediately prior to the menarche. After the menarche the cycles became increasingly regular and the occurrence of ovulation became more frequent.

Plasma FSH-LH-estradiol-progesterone assays were performed in five cases prior to the expectable menarche, with the radioimmunoassay method. The values were nearly identical with those obtained with adults. However, in our investigations neither an ovulational FSH-LH peak, nor progesterone values indicating ovulation have so far been found.

DISCUSSION

In the literature numerous attempts- can be found when the occurrence of the menarche is associated with a critical value of body weight and body height /Forbes 1972, Frisch, Revelle 1970, 1971/. Frisch /1974/ regards the percentual ratio of water content/body weight as the decisive factor.

In our investigations, in spite of the fact that the average body weight and height values were nearly identical with those of Frisch and Revelle /1970/, we could not use these data for the determination of the expectable date of the menarche, since the individual deviations from the average were considerably great. At the same time the point-system of evaluation based on the selected somatic and hormone-cytologic signs was found a simple, quick and reliable method for the approximation of the date of menarche.

Our hormone-cytologic examinations justified the view that the functioning of the ovaries is cyclic even prior to the menarche. In the hypothalamus-hypophysis-gonad system there is a dynamic interaction even in the premenarchal period. The occurrence of ovulation, too, is considerably greater than was previously thought. Considering these data, one can more easily understand that the absence of ovulation may easily lead to disorders of bleeding even immediately after the menarche. In milder cases this leads to amenorrhea, in severe cases it may assume the form of juvenile metropathy, which may even involve danger of life /Borsos et al. 1974/.

The question is important also in view of undesirable pregnancy in puberty, which regrettably occurs with a growing frequency. Just as the menarche, the appearance of secondary sexual characteristics also shows a forward trend. The date of regular ovulation, too, is antedated and the possibility of pregnancy is shifted to an earlier age.

Our hormone assays prior to the menarche, similarly to the values in the literature /Faiman, Winter 1974, Hayes, Johanson 1972, Jenner et al. 1972, Rifkind et al. 1967, Sciarra, Maijnelli 1972, Sizonenko 1971, Sizonenko et al. 1970, Widholm, Kantero 1974, Widholm et al. 1971, Yen, Vicic 1970, Yen et al. 1969/ verify that the most important changes appear at a considerably long time prior to menarche. The menarche, in this way, means the completion of the events and not their beginning.

With the described point-system of evaluation further aimed hormone assays and tests will be performed.

With a greater number of radioimmunoassays, sexual steroid and gonadotropic examinations, in all probability, we may succeed in justifying premenarchal ovulation, too. The present number of our cases is too small to attain this aim.

We recommend our point-system of evaluation not as replacement for Tanner's puberty stage classification, as it has been proved very useful in practice. We only wish to give an easily applicable help to promote the attainment of the objectives outlined in the present paper.

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GROWTH AND MATURATION IN CHILDREN WITH CHRONIC ASTHMA

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ABSTRACT

Growth in height and weight of 442 asthmatic boys aged 3.5 to 20 years was studied at 3-monthly intervals in a mixed longitudinal survey. Absolute measures as well as mean yearly increments have been compared to adequate standards. The pattern of growth of asthmatic boys seems to be determined by a delay in physiological maturation. A significant retardation for growth in height and weight occurs during the time that puberty normally takes place and is due to a delay in the timing of the adolescent growth spurt. A catch-up growth has been observed for height but not for weight.

INTRODUCTION

It has been shown that chronic asthma can impair the growth and development of a child to a more or less extent (Cohen, 1940; Cohen and Abram, 1948; Snyder et al., 1967; Smith, 1963; Schook, 1966; Eberlein et al., 1967; Falliers et al., 1963 and Hauspie et al., 1976_a). Some investigators insist on the disturbance of the normal respiratory function and all the factors related to this phenomenon as a cause of growth impairement; some others think that the retardation in growth observed in asthmatic children is meanly due to prolonged treatment with cortisone or some other analogues.

Whatever the cause may be, it seems indeed that asthmatic children are in the mean slightly shorter than healthy children. But it has never been pointed out clearly if the growth inhibiting effect is equally important at all ages and to what extent final adult stature may be altered.

The purpose of this work was to determine the general pattern of growth in a large group of respiratory handicapped children.

SUBJECTS AND METHOD

We have been able to analyse some aspects of growth in asthmatic children during an extended growth survey held over the past 3.5 years in the Asthma-centre of De Haan, Belgium. The data on which the present study is based are extracted from that survey (Hauspie et al., 1976_b) and extended with information obtained more recently; these data concern height and weight of 442 asthmatic boys followed 3-monthly over periods varying from 3 to 42 months bringing up the total number of occasions on which the children have been seen to 1720.

With such a mixed-longitudinal sample, one should apply the appropriate methods for analysing mixed-longitudinal data, in order to get the maximum information available in it and produce efficient estimates of the population means (Tanner, 1951; Yates, 1949; Patterson, 1950; Goldstein, 1970).

The present study only concerns asthmatic boys. The number of girls in our survey is still rather low (120) so that the figures for the girls are still subjected to more important sampling errors. Nevertheless from a preliminary analysis we observed the same tendencies for girls as for boys, so that most of our findings on the growth of asthmatic boys are equally valid for asthmatic girls.

RESULTS AND DISCUSSION

Figure 1 shows the curves of growth in height for asthmatic and healthy boys. The distance charts (height attained for age) are plotted in the upper section while the mean yearly increments or velocity charts are plotted in the lower part.

The values corresponding to the asthmatic boys are represented respectively by the dots and the broken line, the ones corresponding to the reference groups by the solid black lines.

We now can see that the mean height in asthmatic boys is in general slightly below the standard curve. During childhood this difference is rather small and unimportant but it increases towards the time that puberty normally takes place. The black dots represent the mean values for which the difference is statistically significant ($P < 0.05$). Afterwards, this difference in mean height decreases and towards the age of 19 years the asthmatic boys' mean height reaches the value of normal adult stature.

The yearly mean increments calculated from the longitudinal fraction of the sample on measurements 12 months apart reflect some aspects of the growth trend observed on the distance charts. The mean increments for asthmatic boys are compared to the 50th percentile of the British whole-year velocity standards (Tanner et al., 1966). Although both of these curves are subjected to a phase-difference effect, they still provide a fairly good estimate of the timing of the peak in height growth. Moreover, when compared between them they provide a lot of information on the rate of growth.

During childhood, the mean yearly increments for asthmatic boys are below the normal mean increments. This could effectively result in the gradually increasing difference between the mean heights for healthy and asthmatic boys on the distance chart during that period. The beginning of the pubertal growth spurt in asthmatic boys is observed at the age of normal peak height velocity, this is at the age of about 14 years. The time of maximum mean increment in asthmatic boys occurs about 15 months later

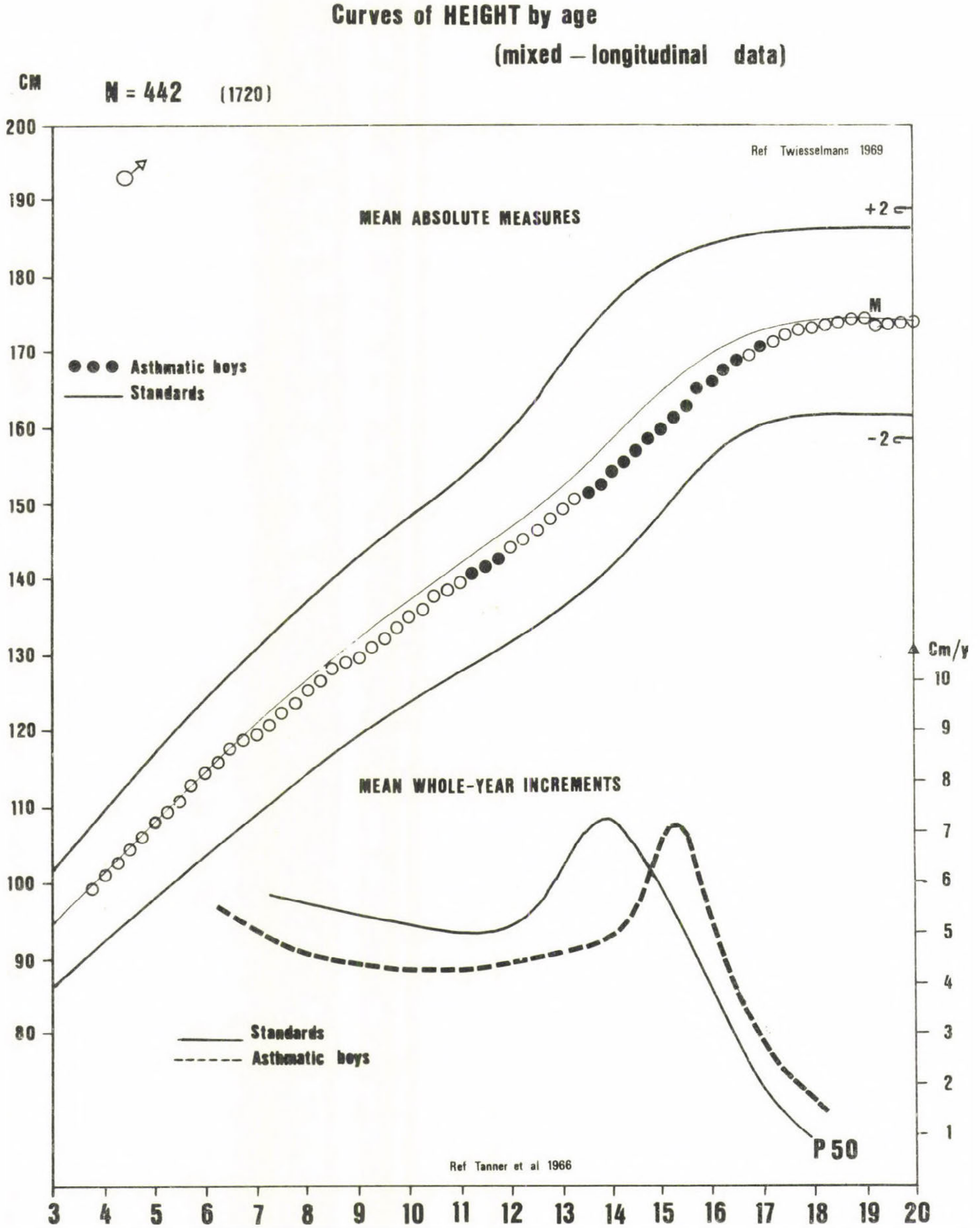

Figure 1. Growth in height (distance and velocity charts) of 442 asthmatic boys.

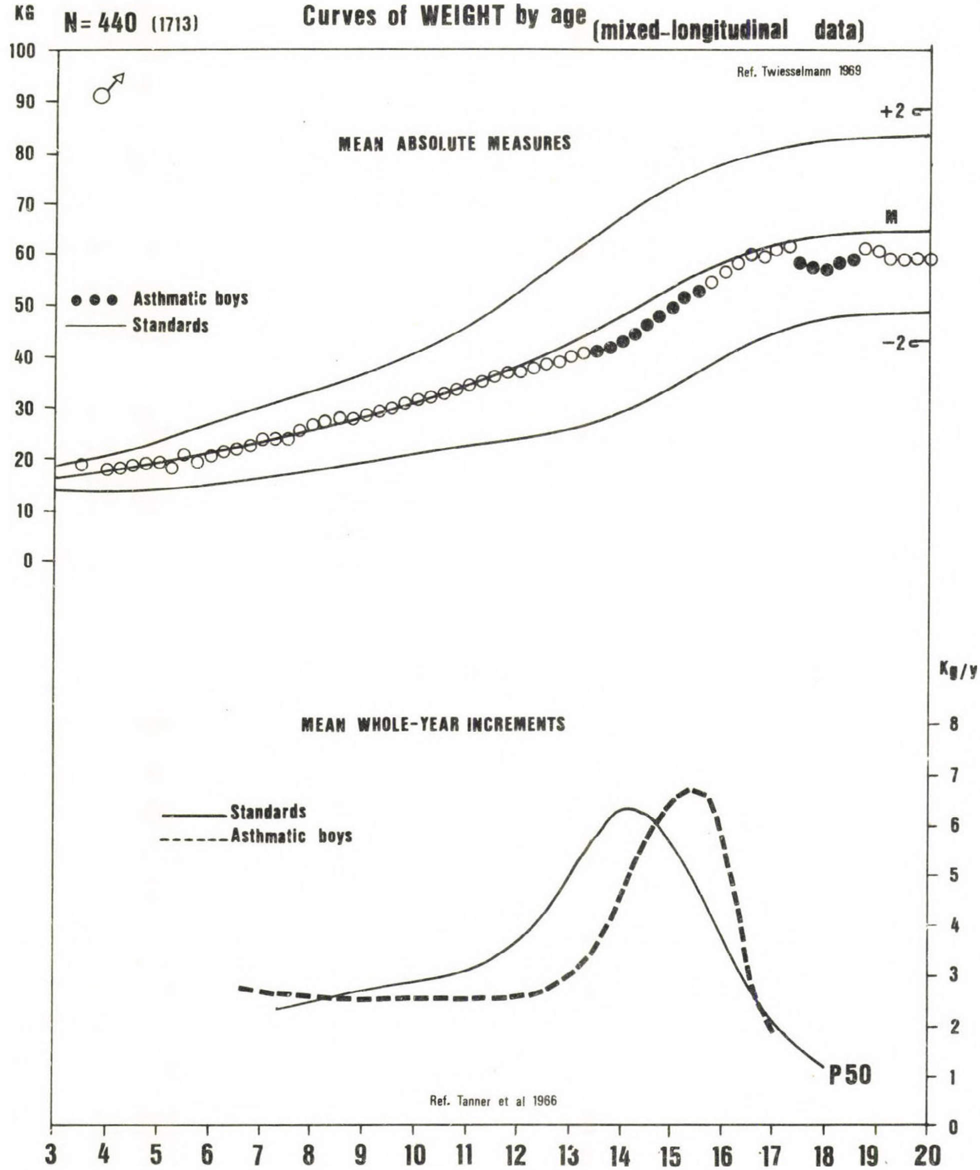

Figure 2. Growth in weight (distance and velocity charts) of 440 asthmatic boys.

than normally seen. Beyond the age of 15 years, the velocity in height growth is consistently higher in asthmatic boys than in healthy boys and at the age of 18 years it is still about twice the normal value.

Figure 2 represents the growth in weight in the same way as for height.

During childhood, the mean values for weight in asthmatic boys correspond fairly well to the reference curve. A delay of also about 15 months in the timing of the maximum mean increment for weight in asthmatic boys is also responsible for a temporary retardation in attained weight at about the age of 14 years. However the adolescent spurt for weight in asthmatic boys is rather sharp and intensive and brings up again the mean distance curve to normal values. Nevertheless, the rapid fall of the yearly mean increments after the age of 15.5 years brings about a stagnation in the growth of weight, resulting in a reduced adult weight.

From these observations we can derive some statements. The asthmatic boys are likely to present a retarded growth in height and weight especially at the time that normal puberty takes place. Growth in height catches up to normal mean values towards adulthood, because the effect of a somewhat delayed growth spurt is compensated by a greater height attained at the beginning of this spurt (+ 6cm) and a slightly prolonged growth period (+ 1 year). The retardation for weight persists during adult ages because of the sharp decrease in growth rate after reaching peak weight velocity.

The data concerning puberty development were available for 91 subjects, randomly selected out of the total group. From these data it seemed that the development of pubic hair was in the mean retarded by about 1.3 years when compared to adequate standards (Hauspie et al., 1976_c). As far as the development of pubic hair is a criterion for sexual maturation as a whole we could say that puberty is indeed retarded in asthmatic boys.

Otherwise, an analysis of the bone age of 660 asthmatic boys indicated that there is also a slight but consistent retardation for bone age at the age of puberty but also before that age, when compared to a reference sample (Hauspie et al., 1976_c).

In conclusion we can state that a delay in physiological maturation is the principal mechanism by which growth is retarded in asthmatic children. An overall slight delay in bone age makes that the total length of the growth period is somewhat extended and explains why these children in general can catch up their retardation in height growth before the growth in length has completely stopped.

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ANTHROPOMETRIC CRITERIA IN THE EVALUATION OF PHYSICAL DEVELOPMENT IN SELECTED CLINICAL SYNDROMES

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ABSTRACT

Anthropometrical measurements have a very essential and undeniable value not only in diagnosis but also in prognosis in developmental medicine. They are particularly helpful in developmental medicine. They are particularly helpful in the analysis of disturbed growth and development as a result of diseases, facilitating the evaluation of diagnosis and the trend of deviation in disease.

The paper describes the results of the analysis of sómatic growth and development in children with phenylketonuria, cystic fibrosis, galactosemia, disorders of the central nervous system /epilepsy and Down syndrome/, who were treated in our institute. In evaluating somatic development, the Warsaw standards have been used as the bases of estimation. The wide range of anthropometric information was analyzed and a tendency for specific values of anthropometric measurements in different diseases was observed.

INTRODUCTION

Present-day research on somatic development is notable for its manysided and complex methods used in the assessment. Among them anthropometric ratings have a definite diagnostic significance. They permit not only to put forward a complete diagnosis on development, but also to find out when, and to what extent, the child's development is slowed down or accelerated. In the event of therapeutical treatment, anthropometric criteria are useful is appraising the effectiveness of the treatment.

MATERIAL AND METHOD

Taking the above needs into account, during 1968-71 the Anthropology Laboratory of the above Institute compiled a voluminous collection of data on physical development of healthy Warsaw children from birth up to seven years of age /Kurniewicz-Witczak et al. 1974/. This set of indices serves as a standard for assessing the extent and directions of deviations in somatic development of children suffering from various diseases.

The present paper gives the results of an investigation dealing with the development of children who were hospitalized or treated in our Outpatient Department, and children with low birth weight who were likewise under supervision.

RESULTS AND DISCUSSION

Phenylketonuria is one of the various genetically conditioned metabolic disorders /Cabalska et al. 1971, Miesowicz et al. 1972/. Its treatment consists in the application of an appropriate diet to obtain optimal levels of phenylalanine in the blood. On the one hand, it prevents damage of the central nervous system, and on the other, it safeguards supplies of phenylalanine, an exogenic amino acid which is indispensable for a correct biosynthesis of organic proteins and therefore for correct growth. Inadequate supplies of amino acids prevent normal growth in height and in body weight, and ultimately lead to under-nourishment and other pathological conditions. Consequently, in assessing the physical development of children suffering from phenylketonuria, it is extremely important to determine the extent of their nutrition. In the case of 70 children whose treatment in the Mother and Child Institute began in the first few weeks of their life, measurements were taken of their height, body weight, and thickness of the skin-fat fold. The results were then compared with the data for healthy children. It was established that, over a period of seven years those children were developing correctly while their height and weight were increasing consistently /Fig. 1/.

Deviation from basic anthropometric characteristics in children suffering from phenylketonuria, whose treatment by applying the diet began late, at the age of one, two, or three years, indicated considerable changes in their physical development as compared with healthy

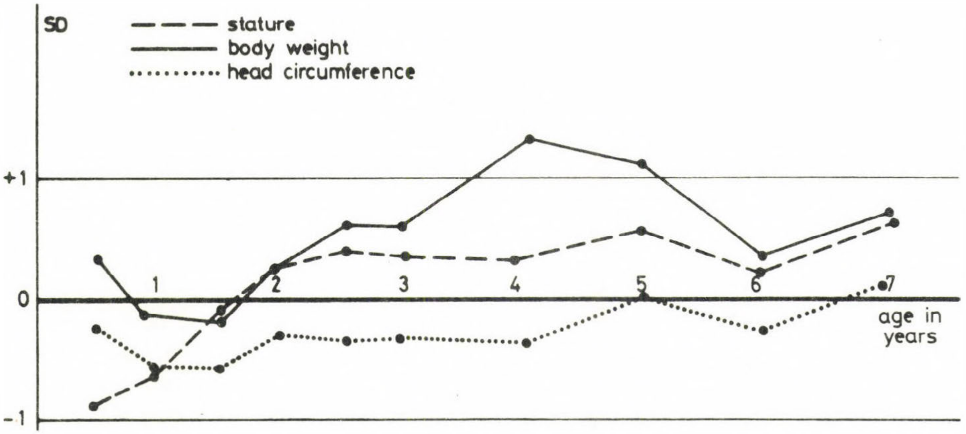

Fig. 1 Height, weight and head circumference in treated children with phenylketonuria in comparison with normal children

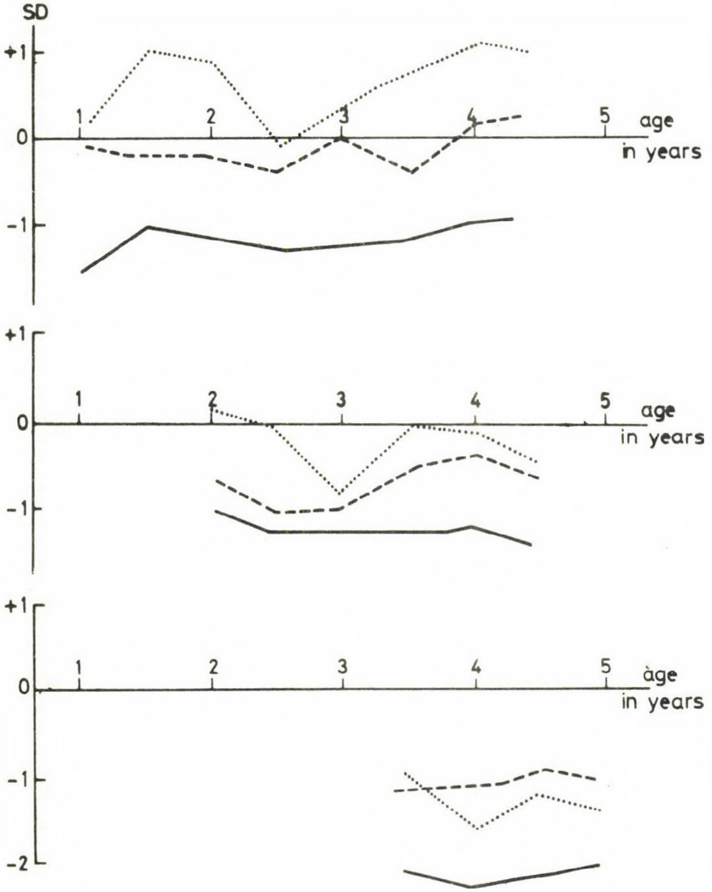

Fig. 2 Attainment curves of height – – –, weight ......, head circumference ———, according to the time of treatment in boys with phenylketonuria

children /Cabalska et al. 1972/. This applied in particular to circumference of the head /-2SD/ which is connected with mental handicap of those children /Fig. 2/.

Research on physical development of children suffering from mucoviscidosis, another genetically conditioned disorder, was conducted in the Pediatric Clinic of the Mother and Child Institute. On analyzing the growth path of those children we noted rapid growth rate and increase in weight only in the cases where mucoviscidosis was diagnosed early and the treatment began without delay. In older children /whose treatment began late/ and in severe cases, we observe considerable underweight in relation to height, and also in relation to the average data for their healthy contemporaries /Bożkowa 1971/.

Clinical status of the patients also affects the development of other somatic characteristics, especially as far as the chest and the fat tissue are concerned. Each child was evaluated individually in accordance with points on the Shwachman scale, taking into account the most important clinical and radiological features characterizing the condition of the patient /Shwachman, Kulczycki 1958/. The smaller the number of points, the severer the clinical status of the patient /Fig. 3/.

A group of boys with most evident disorders, who obtained least points, was characterized by reduced body weight, small fat tussie, narrow shoulders, and considerable depth of the chest. Boys in moderate clinical condition were characterized only by narrow shoulders, disproportions in chest measurements and small fat tissue. The third group, with the highest number of points according to the Shwachman scale, did not differ from healthy children in the level of development of characteristics under analysis.

Assessment of physical development of children with malabsorbtion syndrome was of a special diagnostical value. The first examination of those children revealed the greatest deficit in the thickness of the fat tissue /in specific cases less than -3 SD/, and also, to a somewhat lesser extent, in height, as compared with their healthy contemporaries. Under dietary treatment, the shortcomings gradually disappeared, most rapidly the fat tissue. In the children examined by us shortcomings in the skin-fat tissue were brought to normal after two to six months of dietary treatment. Deficit in height, noted at the first examination were corrected at a slower rate. Correct dietary treatment of small children with melabsorbtion syndrome determines their rapid return to development standards /Fig. 4/.

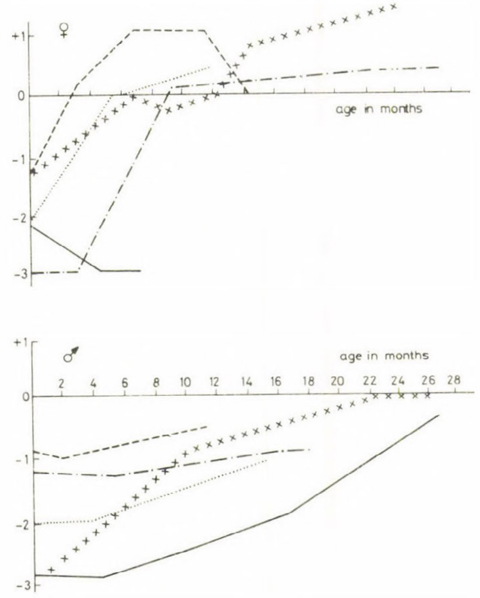

Fig. 3 Standardized values of anthropometric characteristics of children with mucoviscidosis

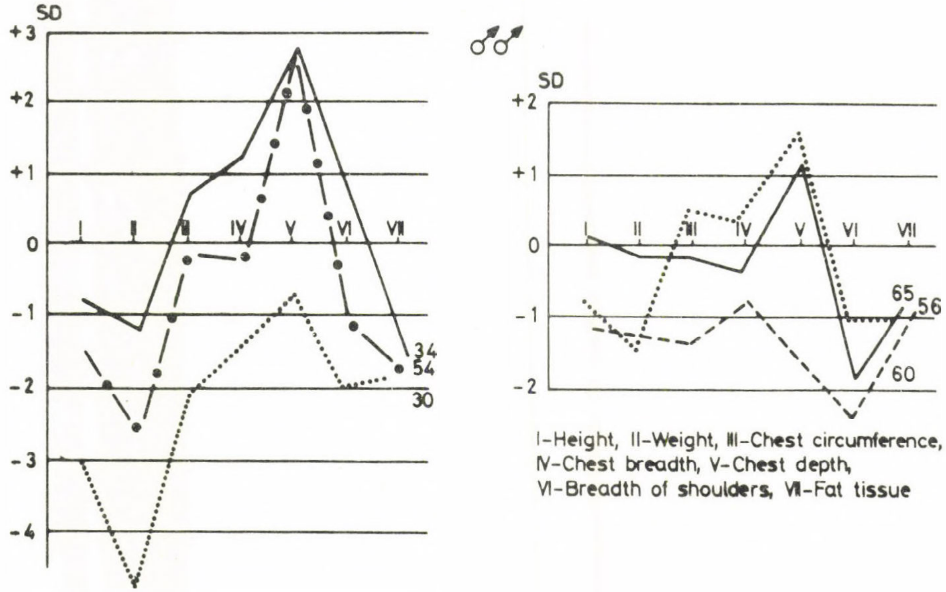

Fig. 4 Standardized values of body weight of the children with malabsorbtion syndrome

Anthropometric indices have also permitted to reveal differences in the development trends in infants born with low birth weight /Mazurczak 1975/. Monthly examinations of infants in their first year of age indicate that those born with intra-uterine distrophy /small for dates/, contrary to infants born prematurely, fail to show a tendency to reduce the difference in development of somatic characteristics as compared with infants born on time and having normal body weight. Also, the growth rate of children small for dates is slower than the growth rate of children born prematurely. The exception is the thickness of the skin-fat tissue where the growth rate is the highest in distrophic infants /Fig. 5a, b/.

The differences in the development of somatic characteristics noted through the application of anthropometric criteria, make it imperative that doctors should apply differentiated development stanrads in their growth diagnosis.

Physical development of children with central nervous system disorders, hospitalized in the Neurology Clinic of the Mother and Child Institute, was also examined. Two groups of patients were differentiated: A - children with infant epilepsy /bending fits - the West syndrome/, and B - children showing other etiological disorders connected with pathological pregnancy and birth /Fig. 6/.

The investigation involved 11 normalized somatic characteristics. It appeared from the analysis that group A obviously deviated from the standard, and differed considerably from group B in the measurements of the head /statistically significant differences in length and circumference of the head/.

Similar methods were used in assessing children with the Down syndrome /Frostad et al. 1971, Gustavson 1964, Schmid, Franz 1971/ who remain under care of the genetical consulting unit of the Mother and Child Institute /Fig. 7/. Standardized profile of their somatic characteristics shows considerable deviations from that for a group of healthy children. It was found that the differences were greater in girls than in boys. The greatest deviations occurred in body length measurements and in the proportions of the head.

In clinical investigations, the head measurements are important elements in growth diagnosis. Consequently, on the basis of the arithmetic mean and standard deviations, charts were prepared for a graphical assessment of the circumference of the head /Czochańska, Kurniewicz-

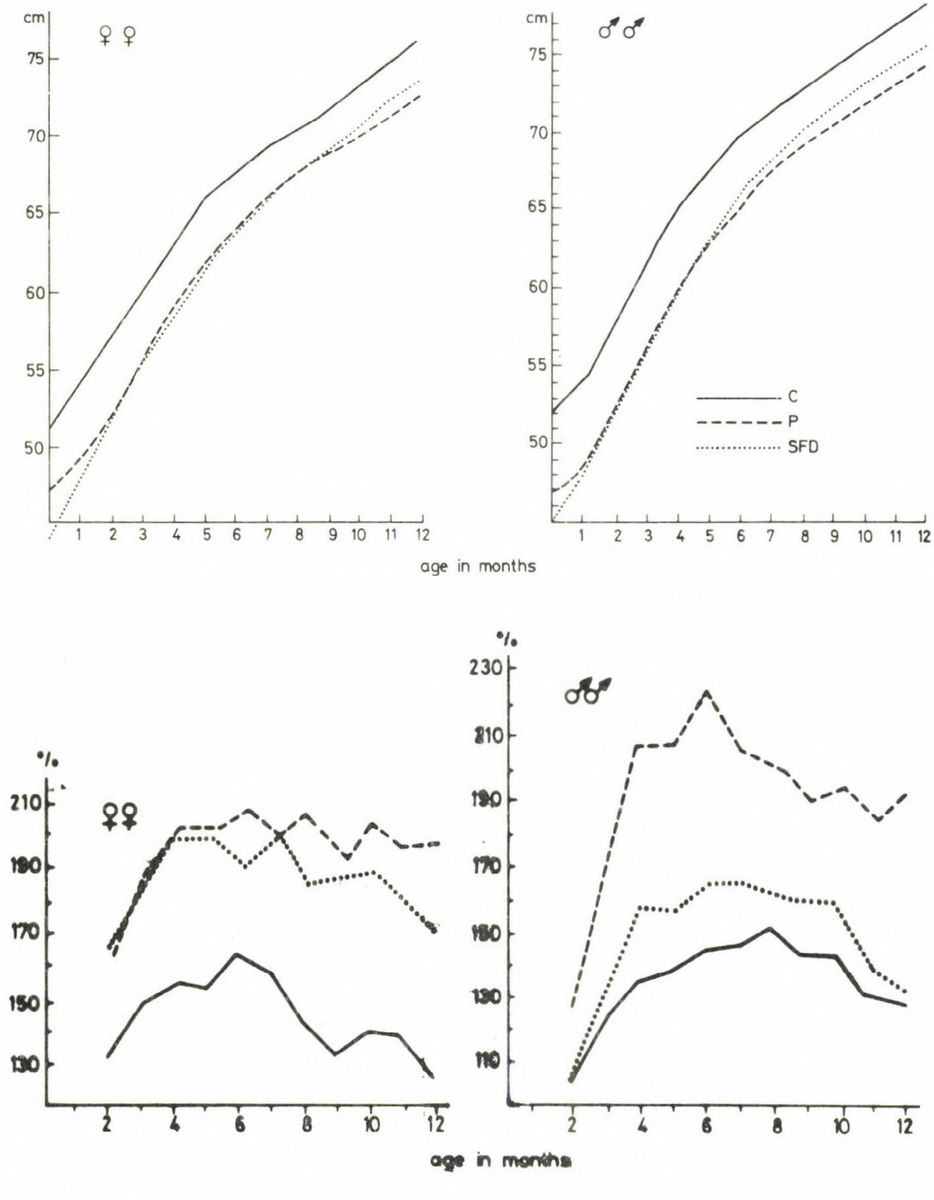

Fig. 5 a: body length: C - control group, P - premature infants, SFD - small for dates infants

b: subscapular skinfold /velocity curves/ in C, P, SFD groups

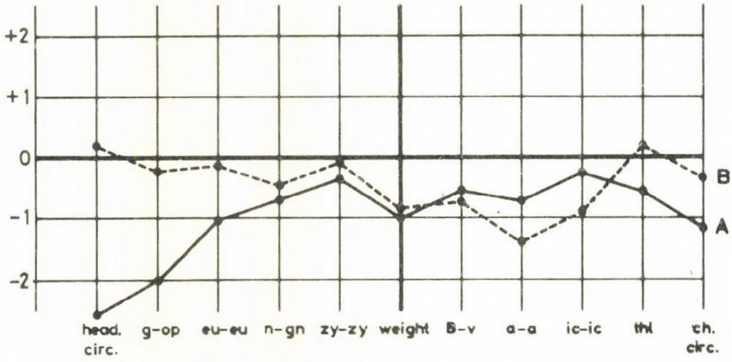

Fig. 6 Standardized values of anthropometric characteristics of children with central nervous system disorders

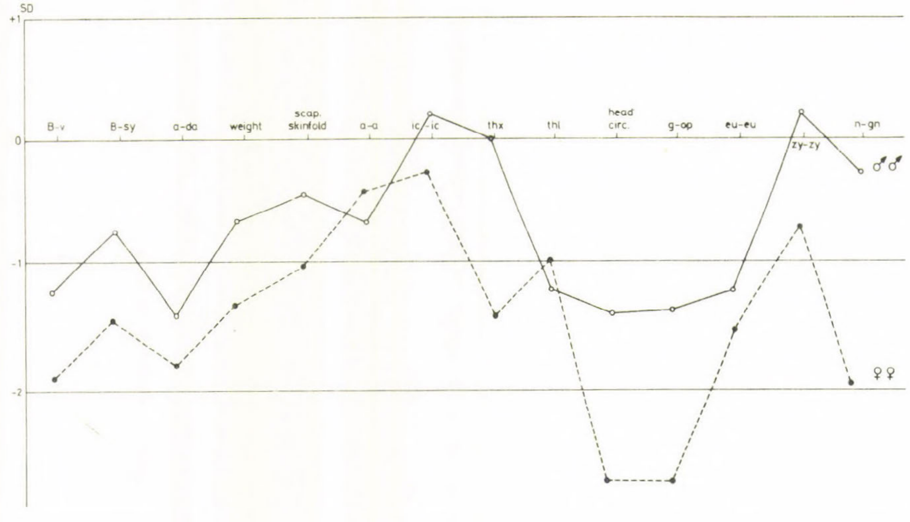

Fig. 7 Standardized values of anthropometric characteristics of the children with the Down syndrome

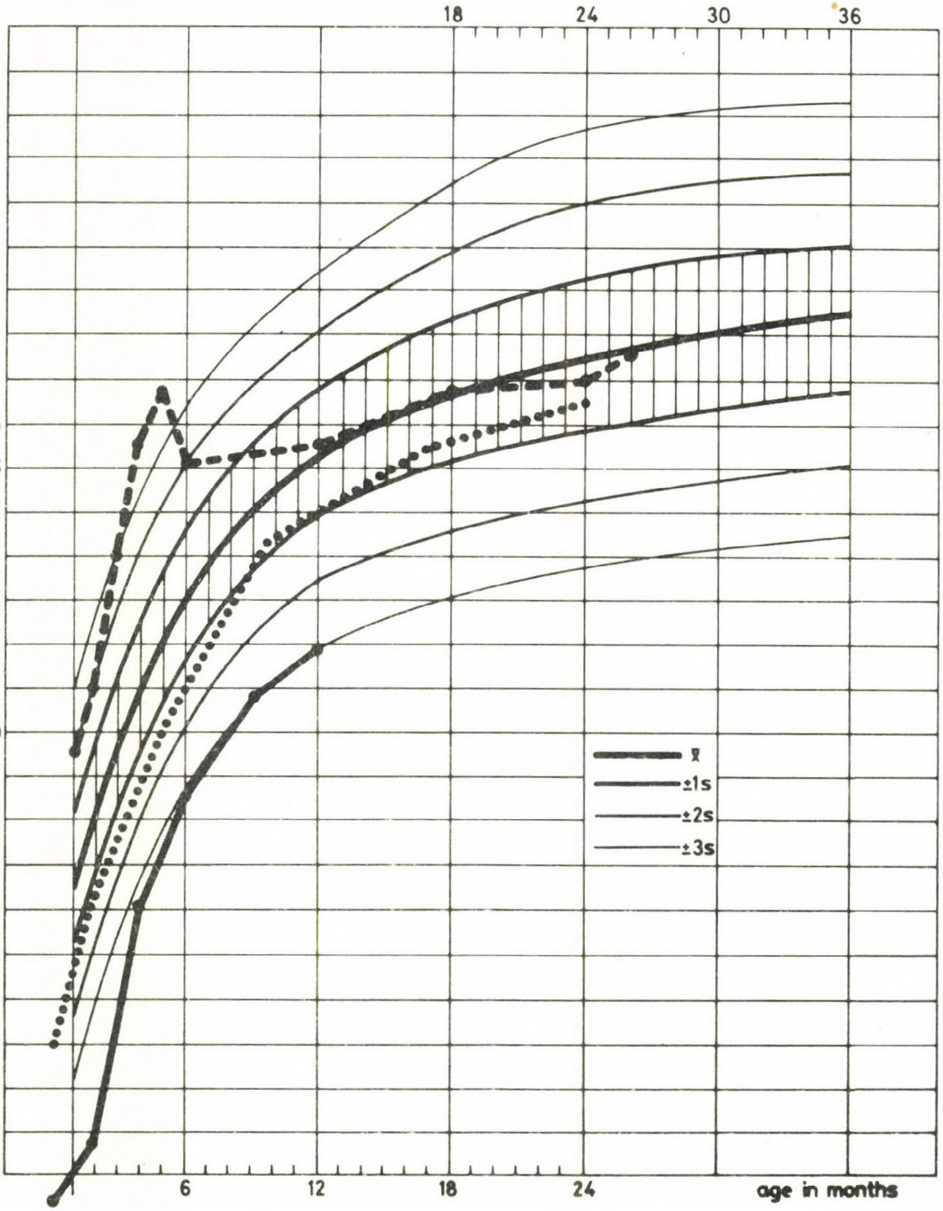

Fig. 8 Head circumference of girls with central nervous system disorders

Witczak 1972, Kurniewicz-Witczak et al. 1974/. Individual cases, representing threc different types of central nervous system disorders, were then superimposed on this chart /Fig. 8/. In congenital hadrocephaly, an intensive enlargement of the circumference of the head was observed, whereas following surgical intervention there was a reversion to measurements typical of healthy children. In the case of primary microcephaly, the circumference of the head keeps throughout the whole observation period at the level of -3 SD. In genetically conditioned metabolic disorders, such as phenylketonuria, where diagnosis was done very late, small increases in the circumference of the head were observed.

An analysis of the data submitted has demonstrated the value and the importance of anthropometric criteria for clinical growth diagnosis and prognosis.

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SOMATIC DEVELOPMENT OF MENTALLY RETARDED CHILDREN

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Introduction

There is scarce evidence in the literature concerning the physical development of mentally handicapped children. It is usually stressed by the authors that the body measurements of such children do not reach those of normal children of similar age. Moiser et al. /1965/ have described a positive correlation between certain measurements and the IQ. According to Szilágyi /1968/ the standard deviation values for body measurements exceed by far those for the normal controls.

Material and Method

In this lecture we represent the physical development of 500 mentally retarded children by means of three body measurements: body height, body weight and chest circumference. The results constitute one part of a comprehensive study, in which also other anthropometric and human biological characteristics have been investigated, and even psychological and sociological analyses have been carried out. It is to be noted that the anthropometric investigations involved the use of the usual methods and tools.

Distribution by age and sex in the group examined is shown in Table 1. The sex ratio approximately represents the boy-girl ratio for mentally handicapped children. The children were without exception ones with moderately severe mental retardation with the IQs varying from 0,50 to 0,25. The material was not broken down according to the etiology of

Table 1.

Distribution by age and sex

Age /years/	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Together n	Together %
Boys	4	7	16	13	24	31	38	50	35	50	37	36	22	10	373	74,6
Girls	-	5	8	7	11	11	12	20	9	13	7	11	8	5	127	25,4

oligofrenia. In the calculations for the means we did not take into consideration those children, in whom one of the symptoms of the etiology of the handicap was a disorder of growth. So for instance we did not take into consideration the children with Down's syndrome, because nanosomia belongs to the symptoms of the 21 trisomia.

The measurements for normal children come from the work by Eiben, Hegedüs et al. /1971/.

Results

The body height values /Table 2./ are lower in both sexes and in every age group than those for the normal children of similar age. The lag increases with the advance of age.

Table 2.

Body height /cm/

	B o y s				G i r l s			
	Handicapped		Normal		Handicapped		Normal	
Age	M	SD	M	SD	M	SD	M	SD
4	100,00	4,22	102,46	4,37	-	-	102,40	4,73
5	106,14	6,73	109,23	4,70	100,80	4,70	109,11	4,58
6	112,88	6,28	115,78	4,87	109,25	4,27	115,13	4,70
7	113,54	7,90	122,46	5,17	111,00	6,14	121,52	5,02
8	122,63	7,19	127,02	5,74	117,36	4,65	127,16	5,16
9	125,47	7,16	132,82	5,68	122,72	7,20	132,57	6,09
10	130,29	8,37	137,83	6,42	130,17	7,42	138,66	7,45
11	136,26	6,95	142,98	6,68	130,77	7,53	143,95	7,34
12	143,63	7,53	148,08	7,10	145,22	9,54	149,68	6,98
13	149,41	11,94	154,12	8,04	147,54	11,56	155,21	6,28
14	151,11	10,58	161,63	8,76	148,28	6,70	157,98	6,01
15	157,50	10,45	166,23	8,52	152,00	7,62	159,75	6,12
16	161,91	9,40	171,31	7,27	150,25	9,18	160,36	5,51
17	160,50	9,72	174,87	6,82	147,00	7,33	160,70	5,66

Between 10 and 13 years of age the body height values for normal girls are somewhat higher than those for the boys. This phenomenon may be attributed to puberty and in the test group we found it only in the 12th year of age.

The SD of body height increases almost steadily in the case of normal children. In the case of the handicapped children a more significant increase of SD was found particularly in the 13th year of age.

The body weight values /Table 3./ were lower in the handicapped group than the means for the normal children, just like it was noted in the case of body height. In the normal group al 11 to 14 years of age girls outweigh boys. In our material this phenomenon occurred between 10 and 13 years of age.

The SD values of body weight increase somewhat with the advance of age in the normal group, while a more marked increase in the handicapped group can be noted at 13 years in the case of boys and at 12 years in that of girls.

Table 3.

Body weight /kg/

	Boys				Girls			
	Handicapped		Normal		Handicapped		Normal	
Age	M	SD	M	SD	M	SD	M	SD
4	16,00	1,82	16,65	2,02	-	-	16,44	2,22
5	17,14	2,34	18,75	2,49	15,80	2,17	18,93	2,93
6	19,56	2,71	21,30	3,07	18,50	2,88	20,88	3,36
7	19,92	4,42	23,94	3,65	18,57	2,37	23,01	3,69
8	24,38	4,69	25,87	4,45	21,45	1,84	25,64	4,31
9	26,42	4,76	29,31	4,87	24,18	3,99	29,21	5,37
10	27,47	3,68	32,27	6,90	29,25	6,82	32,38	6,67
11	30,00	5,76	36,88	8,13	31,50	4,31	37,04	8,34
12	34,17	5,36	39,80	7,97	38,33	5,75	41,28	8,37
13	37,76	16,43	44,05	8,45	39,23	8,21	47,34	9,03
14	42,73	10,86	50,55	9,80	41,57	8,74	50,92	8,16
15	47,42	13,05	54,28	9,39	47,09	10,07	53,31	8,50
16	56,09	8,67	60,38	9,02	49,88	13,41	54,05	7,74
17	55,30	9,20	64,57	8,99	51,00	6,93	55,42	7,69

It is to be noted here that in case we express the lag of a certain body measurement found in a mentally retarded child of a certain age in percentage of the body measurement of a normal child of the same age,the percentage value will be the highest in the case of the body weight. Thus, in our material the body weight lags the farthest behind from among all the measurements examined. This may be attributed, among others, to disorders of absorption, hypenzynemias, as well as parasitisms common in such child communities.

At every age the chest circumference values /Table 4./ of the handicapped boys lag behind those for the normal ones. In the case of girls the chest circumference value for the handicapped reaches the normal value at 17 years of age. From the 13th year on the SD of chest circumference for the handicapped children exceeds that for the normal children.

Table 4.

Chest circumference /cm/

	Boys				Girls			
	Handicapped		Normal		Handicapped		Normal	
Age	M	SD	M	SD	M	SD	M	SD
4	53,00	2,45	54,18	2,47	-	-	53,31	2,78
5	54,00	3,46	55,63	2,62	51,80	2,68	55,31	3,58
6	54,94	3,04	57,87	3,29	54,50	3,08	56,92	3,48
7	56,62	4,15	59,23	3,64	54,71	2,36	57,80	3,71
8	60,60	3,78	61,16	4,75	57,25	2,56	59,99	4,52
9	63,48	4,07	63,64	4,45	59,82	3,64	62,43	5,50
10	63,70	3,70	65,83	5,50	63,33	4,49	65,54	5,72
11	64,96	3,37	69,50	7,48	64,11	4,51	68,87	7,24
12	68,18	4,00	70,74	7,32	69,33	4,12	72,08	7,02
13	71,98	6,87	74,98	6,84	71,23	7,51	76,55	7,75
14	73,78	8,47	78,02	6,72	73,00	6,32	79,74	6,10
15	75,92	6,95	81,19	6,87	78,27	8,50	81,27	6,45
16	84,55	7,01	86,01	5,74	79,63	6,51	81,83	6,03
17	78,10	7,76	88,25	5,43	83,00	6,00	81,47	5,70

From the measurements studied we have computed the Kaup index, as well as the relative chest circumference values. In the handicapped group the Kaup index value /Table 5./ reaches the around 2,00 one characteristic for adults one year later.

The values of relative chest circumference of normal children first decrease, then increase, reaching the around 50,0 value, i. e. half the body height, at the age of 16 in the case of boys and from 14 years on in the case of girls. This tendency can be observed also in our material, but the sequence of values is less regular and apart from a few exception do not reach the values for normal children /Table 5./

Table 5.

	Kaup index				Relative chest circumference			
	Handicapped		Normal		Handicapped		Normal	
Age	boys	girls	boys	girls	boys	girls	boys	girls
4	1,60	-	1,5	1,5	54,00	-	52,88	52,06
5	1,52	1,56	1,5	1,5	50,88	51,38	50,93	50,69
6	1,54	1,55	1,5	1,5	48,67	49,89	49,98	49,43
7	1,55	1,51	1,5	1,5	49,87	49,29	48,37	47,56
8	1,62	1,56	1,6	1,5	49,40	48,78	48,15	47,17
9	1,68	1,61	1,6	1,6	50,59	48,74	47,91	47,09
10	1,62	1,73	1,6	1,6	48,89	48,65	47,76	47,27
11	1,64	1,86	1,8	1,7	47,67	49,21	48,61	47,84
12	1,66	1,82	1,8	1,8	47,47	47,74	47,77	48,15
13	1,69	1,83	1,8	1,9	48,18	49,28	48,00	49,31
14	1,87	1,89	1,9	2,0	48,83	49,93	48,27	50,47
15	1,91	2,08	1,9	2,0	48,92	52,15	48,84	50,87
16	1,95	2,12	2,0	2,1	48,96	52,99	50,20	51,03
17	2,14	2,14	2,1	2,1	52,22	53,46	50,46	50,69

Discussion

Thus, our investigations confirm the view that the physical measurement values of oligophrenic children are usually lower than those for the normal children of a similar age. The lag seems to increase with the advance of age in most cases. It is to be noted that also the measurements not discussed here, but determined in our investigations show a similar tendency.

The SD values of the physical measurements increase somewhat with the advance of age in the normal child population, though less than in the case of the mentally retarded group studied.

This is due to the fact that we did not group our material according to the etiology of oligophrenia. Had we done so, we should have obtained lower SD values for the homogeneous etiological groups in all likelihood.

The SD values showed a more marked increase in the years 12 and 13. This may presumably be attributed to the faster rate of growth caused by puberty, which in the case of the mentally retarded group studied takes a protracted course.

These problems raise the importance of investigations into the development of mentally retarded children on more extensive and etiologically differentiated material. The necessity of longitudinal studies also emerges. Our own such investigations are in progress, but the results cannot be reported on yet.

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HORMONAL CHANGES IN ADOLESCENT ATHLETES

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Abstract

In previous studies even maximum physical exercise was found to give rise to a moderate steroidemia only. Submaximum exercise does not elicit any measurable change in the pituitary-adrenal system. In the physically trained organism blood steroids become eliminated at a faster rate both in case of an endogenous steroidemia and after exogenous /intravenous/ steroid administration. In the present work these problems were studied in adolescents, i.e. in their dependence on age, but also in respect of the effect played by the different branches of sports.

Pituitary-adrenal response in the adolescents was like that in adults, but postexercise rises were even smaller than at a later age. This could be explained by the observation that young subjects, as also untrained adults, were unable to work so hard as necessary in order to trigger to steroid response. Age dependence was most conspicuous in steroid elimination; excretion is faster in the young.

Introduction

Not only is regular training begun earlier in several events of sports, but also top performance has become achievable by increasingly younger athletes in the last decade. This trend is particularly characteristic of swimming and also the improvement of the best results is most spectacular here. It may generally be stated that the top ranks of sports have become younger in almost every event, and many of the talented athletes reach international standards in their teens. This implies that the athlete whose period of best performance coincides with the postpubertal years, namely from 15 to 19, must have participated in regular intense training work already before and during puberty. This state of affairs applies to boys and girls alike.

In agreement with many other reports published after 1960, we have been opposed to accepting the traditional medical opinion that assumes an increased vulnerability during the periods of fast development and growth and warns against any intense training in adolescents. Quite queerly, the endocrine functions of the adolescent athletes have until now failed to arouse a similarly widespread interest though the involvement of the hormonal control processes is quite obvious in puberty.

The purpose of the present paper is to demonstrate the pituitary-adrenal response patterns given to definite laboratory and field exercise tests by athletic and non-athletic subjects in the age range from 9 to 19 years. The basis for discussing the relevant results is the experience gained by previous studies in adult athletes. In connexion with the age factor mention will be made of another of our studies dealing with the excretion of steroid hormones.

Material and Methods

The exercise response of the hypothalamic-pituitary-adrenal system was investigated in 147 youngsters. The observed changes in the serum cortisol level are regarded, in conformance to the suggestion of Guillemin and associates, as a measure of the induced activation.

Serum cortisol was estimated by Mattingly's fluorometric technique as modified by Faredin /1974/. The laboratory exercise was either submaximal or maximal. During the all-out exercise the subjects ran on a Jaeger treadmill set to a belt speed of 12 km/h. After 4 minutes of running horizontally the work load was increased by raising the treadmill inclination every second minute. The subjects ran until exhaustion; this occurred usually after 6 to 10 minutes. In the submaximal exercise treadmill speed was 1o km/h at an inclination of 5 %.

After the oral administration of 2oo mg of spironolactone renal excretion was studied for 72 hours. In the three 24-hr portions of collected urine the amount of canrenone, the excreted thioacetylated metabolite of spironolactone was determined by gas chromatography.

The statistical significance of the differences was analysed by Student's t-test.

Results

Fig. 1 shows the submaximum laboratory and event-dependent exercise tests in swimmers aged from 12 to 14 years, respectively in 14-to-16-years-old handball players. Serum cortisol was unaffected by these exercises. Moreover, if the preexercise level was higher, after the exercise even a reduction was seen.

The effects of the all-out runs are shown in Fig. 2. They refer to 9-to-16-years-old competitive athletes of various disciplines and to young subjects not involved in regular training. Mean aerobic power, postexercise pH, age and event are indicated for all groups to reflect endurance fitness as well as exercise stress. As shown, a relatively moderate, but consistent postexercise rise took place in the serum level of some groups. In the non-trained group the postexercise level was markedly higher.

Fig. 3 demonstrates those of the well-trained subjects in whom preexercise serum cortisol was higher than the upper 18 microgram per cent boundary of the normal range. The postexercise level was obviously lower in these cases.

Canrenone excretion is shown in Fig. 4. This study of the 19-years-old athletes involved both resting and training days. The results were compared to non-athletic subjects both of the same age and of 45 years. Each group consisted of 8 subjects here. The respective effects of age and training can be clearly seen. Those of the same age reflect the difference in training condition: the better trained group is characterized by a faster excretion. The age factor is demonstrated by the higher rate of excretion in all the younger subjects.

Fig. 1. Serum cortisol of swimmers and handball players after submaximum ergometric and event-dependent exercise loads

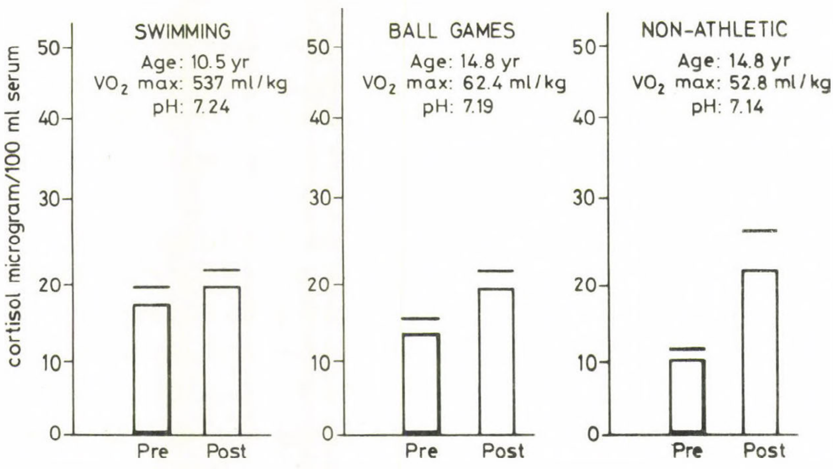

Fig. 2. The effect of maximum intensity ergometric exercise on serum cortisol in adolescent athletes I.

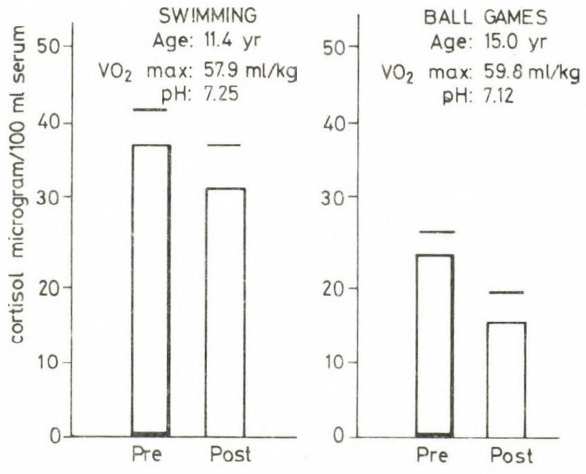

Fig. 3. The effect of maximum intensity ergometric exercise on serum cortisol in adolescent athletes II.

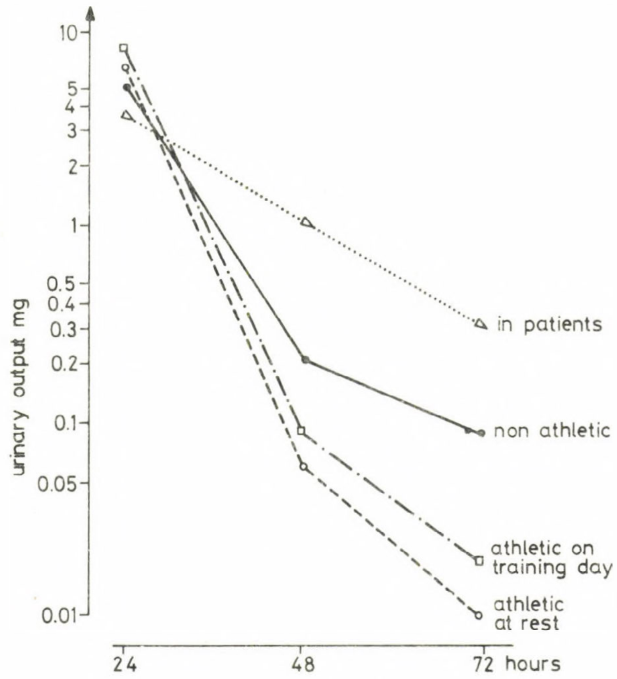

Fig. 4. Comparison of canrenone excretion in humans

Discussion

These results actually correspond to those previously obtained concerning the hypothalamic-pituitary-adrenal responsivity in <u>adult</u> athletes of various events. The pertinent data were reported at the Third European Congress of Sports Medicine /Frenkl et al. 1974/, respectively at the Fifth World Congress of Endocrinology /Frenkl et al. 1976/.

Thus it may be stated that submaximum exercises do not affect the serum cortisol level in adolescents either. A good training condition is characterized by a slight rise after maximum intensity laboratory exercise. Any serum steroid response in excess of this is most likely to be the result of psychological factors in the well-trained subjects. The slightly higher corticoid level of the serum after a laboratory exercise may be related to the metabolic changes taking place during and after muscular work. Non-trained subjects are usually uncapable of performing an exercise of sufficient intensity to elicit these metabolic changes. If, however, they are capable to do so by straining themselves, their response is characteristically higher than that of their better trained mates.

The observation of the higher preexercise corticoid levels, too, is mainly attributable to the effect of psychogenic factors. This in athletes is often an indication of poor disposition or decrease in sports form. If they are subjected to a high submaximal or all-out exercise in this condition, the postexercise value usually is one of the same or a lower level.

The adaptive process started and maintained by a regular training regime is also shown by the faster excretory rate of steroids which takes place in addition to the changed response of the pituitary-adrenal system. These findings corroborate our assumption that, similarly to the cardiorespiratory training phenomena, the adaptation of also the endocrine and metabolic processes is manifested by a shift towards an optimum economy in functions.

Finally, let us return to our basic problem concerning the admissible training load of the endocrine system in adolescence. The data reported here need naturally supplementation both in regard of their scope of sports events and of the concerned exercise models. It appears, however, that an adequate adaptive capacity of the hypothalamic-pituitary-adrenal system to regular exercise is warranted both in childhood and adolescence. The allotted time disallows me to discuss the relevant animal experiments, thus I can but allude to the observations that the adrenal cortex of the rat shows an adequate response to various types of exercise from an age of some weeks until senility /Gleispach 1974, Okinaga et al.1976, Frenkl et al. 1975, Stark 1976: Personal communication/.

The findings of these endocrine studies are, therefore, in disagreement with the theory of an overcareful exercizing of adolescents. They rather favour the opposite view, namely that adolescence is a period of primary importance for laying the foundations of not only top performance, but - more generally - of developing the well-trained adult physique as well. Naturally, the precondition of any intense physical training remains the complete healt of all candidates.

Acknowledgement

Dr. P. Apor for directing the all-out treadmill experiments.

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THE IMPACT OF ECOLOGICAL FACTORS ON SOMATIC AND MOTOR DEVELOPMENT OF PRESCHOOL CHILDREN

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Abstract

The development of somatic and motor parameters in preschool boys and girls is already significantly differentiated, and in some cases also the reaction to selected stimuli appears to vary according to sex. Accelerated somatic development due to different factors (e.g. living in a big city, in a better economic situation, ranked as first in the family etc.) is not always parallelled by simultaneously and correspondingly accelerated functional capacity and motor performance; obviously when evaluating the optimality of child development, functional parameters ought to be analyzed simultaneously. Highest level of both somatic and motor development was found in children with regular exercise and kindergarten attendance.

Introduction

The growth rate and level achieved at different stages of development in children are among the most sensitive indicators of environmental influences. The organism of the child, especially in the early periods of ontogeny is specially sensitive to different stimuli, both positive and negative. This is apparent when comparing e.g., the growth and development of children from developing countries with those from industrially developed countries, where above all nutrition, hygiene and health care vary markedly.- Mainly height and weight, simply measurable parameters, are considered indicators of developmental level. Some of the observations show nevertheless that also other parameters ought to be taken in account (e.g. functional capacity of the organism, and the prognosis of health). Even when greater values of height and weight are considered characteristic of more favourable development, bigger does not always mean better as indicated by selected studies e.g. in adolescents (Pařízková and Merhautová 1970). Very few observations of this type concern younger children, i.e. preschool children. Therefore, the impact of selected factors of the environment on morphological and motor development was analyzed in this age group of children.

Material and methods

A representative sample of 2674 boys and 2775 girls at the age of 6.4 years from Bohemia and Moravia was followed just prior entering the first class of primary school. Selected parameters of somatic development (Weiner and Laurie 1969), social characteristic, body posture, physical performance in special disciplines, skill tests and sensomotor development teste were evaluated (al-together 45 parameters - Pařízková and Berdychová 1975). Standard values for the mentioned parameters were thus obtained for children of this age characterizing also the maturity for school attendance.

Results and discussion

Significant sexual differences were found: boys were taller, heavier, had greater circumferences of chest and abdomen (Fig.1). Circumferential measures of the arm and thigh were significantly greater in girls, obviously due to greater deposition of subcutaneous fat as shown by previous measurements (Pařízková 1963, 1976). Girls tended to have better body posture (Berdychová and Pařízková 1975). Performance in 20 m dash, broad jump from the spot and cricket ball throw were significantly better in boys compared to girls (Fig.2), who displayed on the other hand significantly better results in skill test (i.e. walking a beam, standing on one foot, forward roll, catching a ball etc.) and sensomotor tests according to Keogh (1968) i.e. "open-close hands test" in its more complicated items (Pařízková and Berdychová 1975). As apparent at this age there are already significant sexual differences not only in somatic but also motor development of children (which is relevant e.g. for organized physical education in preschool age).

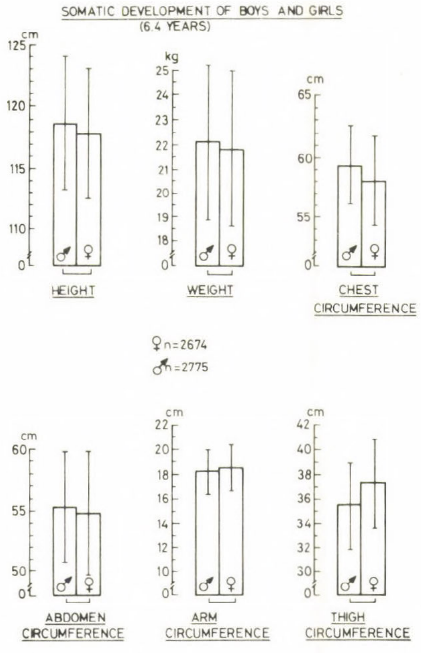

Fig.1

When children were classified according to the ecological situation (living in a capital with more than one million inhabitants or in small communities) both boys and girls from the capital displayed higher values of height, weight and chest circumference. Boys from the capital were characterized by a more linear constitution. In spite of better results in sensomotor tests, children from the capital had a significantly poorer performance in 20 m dash, and boys also in cricket ball throw (Tab.1). Greater bodily dimensions and better disposition as regards sensomotorics did not imply automatically a better performance in the mentioned disciplines, obviously due to the lack of proper motor stimulation and restriction of spontaneous physical activity in a big city. In the families of children from the capital there was a greater per capita income, which also has an important impact on the somatic and motor development of the children : boys and girls from the families with the highest

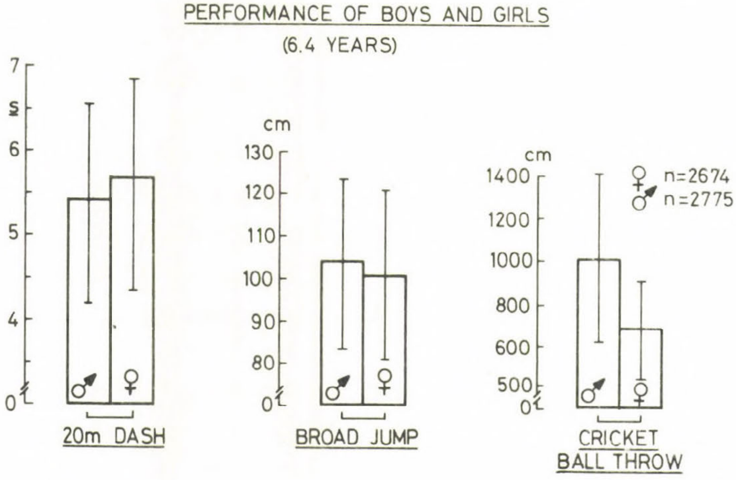

Fig.2

economic level were always taller and heavier than children from families with the lowest economic level (i.e. lowest per capita income). In both cases nevertheless the mean values of height and weight were within the norm for Czechoslovak population (Kapalín 1967). Also in this case greater somatic dimensions did not imply a generally better predisposition for physical performance; the results in 20 m dash in boys were significantly worse in those from families with the highest per capita income (Tab.2), but were better in broad jump.

Accelerated somatic development and greater bodily dimensions were also apparent in first born children in the family compared to those born as fourth - fifteenth. In this case too the performance in 20 m dash or cricket ball throw was worse in the first born but only in girls compared to those ranked as fourth etc. (Tab.3). - First ranked children were most often only children, from families with a higher per capita income, and from bigger cities where families tend to be smaller. As follows, a higher standard of living which exists in greater agglomerations, in richer families etc. does not seem to create automatically conditions for better functional capacity and performance even in preschool age.

More favourable results as regards somatic development were

Table 1

Somatic and motor development in preschool children from the capital and from smallest villages

		Prague (n ♂ = 252, ♀ = 254)			Villages with less than 1000 inhabitants (♂=331, ♀=315)	
		$\bar{x}$	SD	(stat.sign.)	$\bar{x}$	SD
Height (kg)	♂	120.2	5.7	xxx	117.9	5.0
	♀	118.5	8.4	xxx	116.8	5.5
Weight (cm)	♂	22.7	3.3	xxx	22.2	3.1
	♀	22.5	3.4	xxx	21.3	3.0
Chest circumference (cm)	♂	60.1	3.3	xx	59.3	3.4
	♀	59.3	4.1	xxx	57.4	3.3
20 m dash (s)	♂	5.9	1.3	xx	5.5	1.1
	♀	6.3	1.7	xx	5.7	1.3
Broad jump (cm)	♂	106.9	20.4		104.9	19.6
	♀	102.5	21.5		100.4	18.3
Crickett ball throw (cm) (right hand)	♂	545.7	325.1	xx	1118.4	407.2
	♀	669.0	209.9		702.2	239.2

also found in children with longest kindergarten attendance compared to children in family care only. In this case accelerated growth was parallelled by better performance. Further analysis was performed according to the situation in the family (evaluated by three grades: 1- very good, 2- broken up family, 3- divorced parents). The impact of an unfavourable family situation seemed to be more apparent in boys of our group. There was a trend towards lower values of somatic parameters (e.g. body weight in boys of group 3 was significantly lower than in the boys of group 1). In this case the motor performance in children of group 3 was poorer. In girls the differences according to family situation was not so apparent.

When children with regular physical education were selected from our representative sample and compared with children with no systematic exercise greater body height, weight and chest circumference together with higher level of performance (e.g. longer broad jump, and longer cricket ball throw) were found in children with regular exercise (Tab.4). Although the bias of selection may play a part in this case (i.e. that less developed and fit children prefer to avoid exercise; this applies partly also to kindergarten attendance, where parents of such children prefer to have them at home) the positive impact of exercise even at this age seems to be apparent.

Table 2. Somatic and motor development in preschool children according the economic level (statistical significance of differences xxx $p<0.001$, xx $p<0.01$, x $p<0.5$)

Economic level		Highest (n ♂ = 88, ♀ = 115)			Lowest (n ♂ = 457, ♀ = 452)	
		$\bar{x}$	SD	stat. sign.	$\bar{x}$	SD
Height (cm)	♂	121.1	5.6	xxx	118.2	5.7
	♀	119.9	5.8	xxx	117.4	5.6
Weight (kg)	♂	22.5	3.4	-	21.8	3.2
	♀	22.3	3.6	x	21.5	3.6
Chest circumference (cm)	♂	59.1	3.3	-	58.7	3.0
	♀	58.6	3.8	-	58.0	4.0
20 m dash (s)	♂	5.9	1.8	xxx	5.3	0.9
	♀	5.9	1.6	-	5.7	1.2
Broad jump (cm)	♂	111.2	24.1	xx	103.9	22.2
	♀	103.6	22.7	-	99.0	20.8
Cricket ball throw (cm)	♂	1077.1	368.6	-	1045.9	385.0
	♀	679.7	253.0	-	708.5	226.0

Table 3. Somatic and motor development in preschool children according to the rank of birth

Rank of birth		1st (n ♂=1419 ♀=1345)			4 - 15th (n ♂= 79 ♀ = 84)	
		$\bar{x}$	SD	stat. sign.	$\bar{x}$	SD
Height (cm)	♂	119.1	5.4	xxx	115.9	6.4
	♀	118.2	5.0	xxx	115.6	5.9
Weight (kg)	♂	22.4	3.3	xx	21.0	3.4
	♀	21.9	3.4	xx	20.6	3.5
Chest circumference (cm)	♂	59.5	3.5	xx	58.5	3.0
	♀	58.0	3.8	-	57.4	3.7
20 m dash (s)	♂	5.5	1.2	-	5.5	1.1
	♀	5.8	1.3	xxx	5.3	0.6
Broad jump (cm)	♂	107.9	21.0	-	106.8	21.5
	♀	99.5	19.8	xx	106.5	19.3
Cricket ball throw (cm)	♂	1033.4	390.3	-	1009.3	387.0
	♀	669.7	218.9	xxx	804.4	267.7

Table 4. Somatic and motor development in preschool children with different physical education

Physical education (years)		0 (n ♂=2601 ♀=2264)			2-3 (n ♂= 87 ♀ =150)	
		$\bar{x}$	SD	stat. sign.	$\bar{x}$	SD
Weight (kg)	♂	22.2	3.2	xxx	23.6	2.3
	♀	21.6	3.3	-	22.1	3.6
Height (cm)	♂	118.6	5.3	xxx	120.8	5.1
	♀	117.6	5.2	xxx	119.0	5.5
Chest circumference (cm)	♂	59.2	3.3	xxx	61.0	3.4
	♀	57.9	3.7	-	58.2	4.1
20 m dash (s)	♂	5.4	1.1	-	5.5	1.2
	♀	5.7	1.2	-	5.7	1.2
Broad jump (cm)	♂	108.0	20.9	xxx	119.9	22.3
	♀	100.7	20.4	xxx	110.6	18.4
Cricket ball throw (cm) (right hand)	♂	1060	391	-	1081	419
	♀	676	220	x	717	240

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PHYSICAL FITNESS IN BOYS AND EFFECTIVENESS IN SPORTS AT SCHOOL

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The discussion about the sport lesson at school is by no means new, wether it concerns the desirable or possible frequency per week or the effectiveness of a particular discipline.

With our contribution we intended to carry more transparency into this problem. So we started off by evaluating the attitude of pupils towards school sport through an opinion test by means of a questionnaire. Through direct questions we expected clarification whether pupils see a connection between the school sport lesson and health - also which respective rank they consider the school lesson to represent. 54, 7 % of the boys thus interrogated regard school sport in this respect as "very important" and further 37, 9 % at least as "useful" - this means that approximately 93 % of the boys consulted take a positive attitude towards school sport.

If we apply the same question to spare-time-sports even 97, 5 % of the boys were of the opinion that such activities have a favourable influence upon one's health. A reverse reaction was obtained when we inquired about top-sports-performance. Only 37, 7 % feel that there could be positive influence upon health, whilst 62, 3 % of the boys see top sports performance of negligible importance, or - surprisingly - 46 % of the total consider such practice as contradictory to health. Especially the rating of school sports is in my opinion of utmost importance. Obviously there is a tendency in young people towards school sports. It must be possible for teachers creating the necessary motivation to achieve a positive effect.

A couple of years ago and for some time the FRG introduced a special "Sports High School" on a trial basis which united boys particularly keen on sports in school class units with emphasis on sports in general and special promotion for each one in his particular discipline. To guarantee a certain level at school an acceptable performance concerning other subjects was a precondition for joining. During a term of one year at school the capacity of the boys of one class-unit was closely examined through various functional tests. Boys of ordinary classes underwent equal investigations during the same period of time. We found distinct differences between the two class-units in respect of an increase in the capacity of the heart-circulatory-system as well as an improvement regarding the reaction time. Fig. 1 shows the difference between the initial form and also the later distance comparing both classes considering the most significant statistical points. The boys of the sport class exceeded by far their age group in a normal class by multiplying their physical fitness. 2 years after conclusion of this school test the boys of the sport class who were in the meantime organised in school groups exercising sport to their inclination underwent once again such tests. We found that the change from "sports class" to "ordinary class" produced clearly a negative effect always taking the development of the physical capacity into account. Whilst the carrying capacity of the heart-circulatory-system during one year in the sports class increased by approximately 32 %, during the two following years we noted an additional increase of 4, 5 % only. That means the ratio in capacity and performance dropped below the normal growth rate. The muscle strength which had grown by about 33 % during one year at sports class showed a mere 3 % increase during the two following years. This result was in principle uniform covering all physiological and psychological parameters which were tested by us. Obviously the motivation is much higher in a sports class compared to the ordinary groups following their inclination thus indicating a direct relationship to continuesly applied overextended training stimuli.

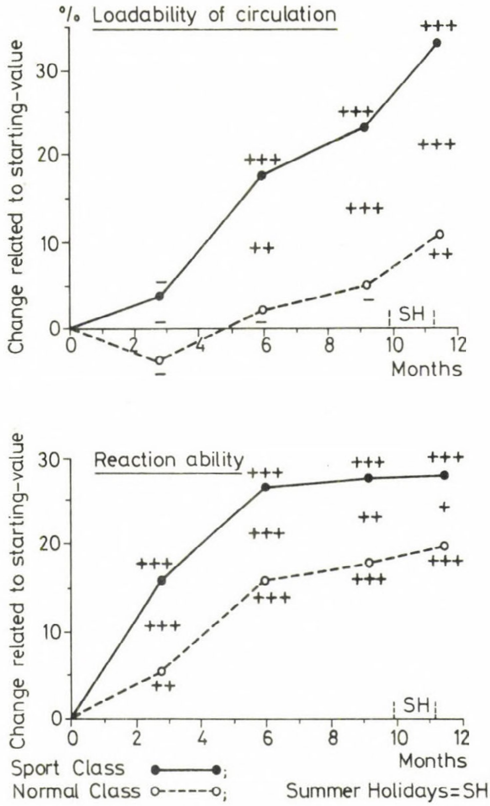
Furthermore we registered the actual time of activity during the course of the usual 45 minutes of a sport lesson which depends - by no means a new realisation - upon the type of exercise. For instance "team sports" produced an actual activity time of approximately 55 % which means 25 min, Gymnastics however about 17 % or less than 8 min. These results confirm the findings of WEIDEMANN, MARQUARD, DIETRICH and others.

We continued by measuring permanently the pulse rate during sports lessons combining groups within brackets of 20 to 20 pulses and demonstrated this distribution curve as per fig. 2. The top line shows the average result obtained during lessons of identical exercise, for instance the jumps, the medium line types of sport belonging together such as team sports. And finally the bottom line compromising the average results of the total test series. The average pulse rate increased only with team sport by 15 pulses/min compared to other groups. Obviously during the athletic and especially gymnastics considerable time of inactivity with reduced pulse rates contribute to this result. Studying the outcome of all sport lessons we found an average pulse rate of 134/min. The increase in pulse rate during a lesson is quite often not just due to a dynamic muscle strain but - predominantly in all kinds of team sports- much more to psychological stress. It is known that such growth in pulse rate does not produce a training stimulus for the heart-circulatory-system.

We then tried to find means to increase the efficiency of the sports lesson through the introduction of a special 10 minutes-training-program considering the biological laws of body training. Fig. 3 shows the sequence of the pulse rate during 10 minutes of training as well as the indication as to which body system was engaged. Naturally the highest pulse rates appeared during training of the heart-circulatory-system. During the course of such training one finds two sections in which the pulse rate exceeded 150/min during a period of each time more than two minutes.

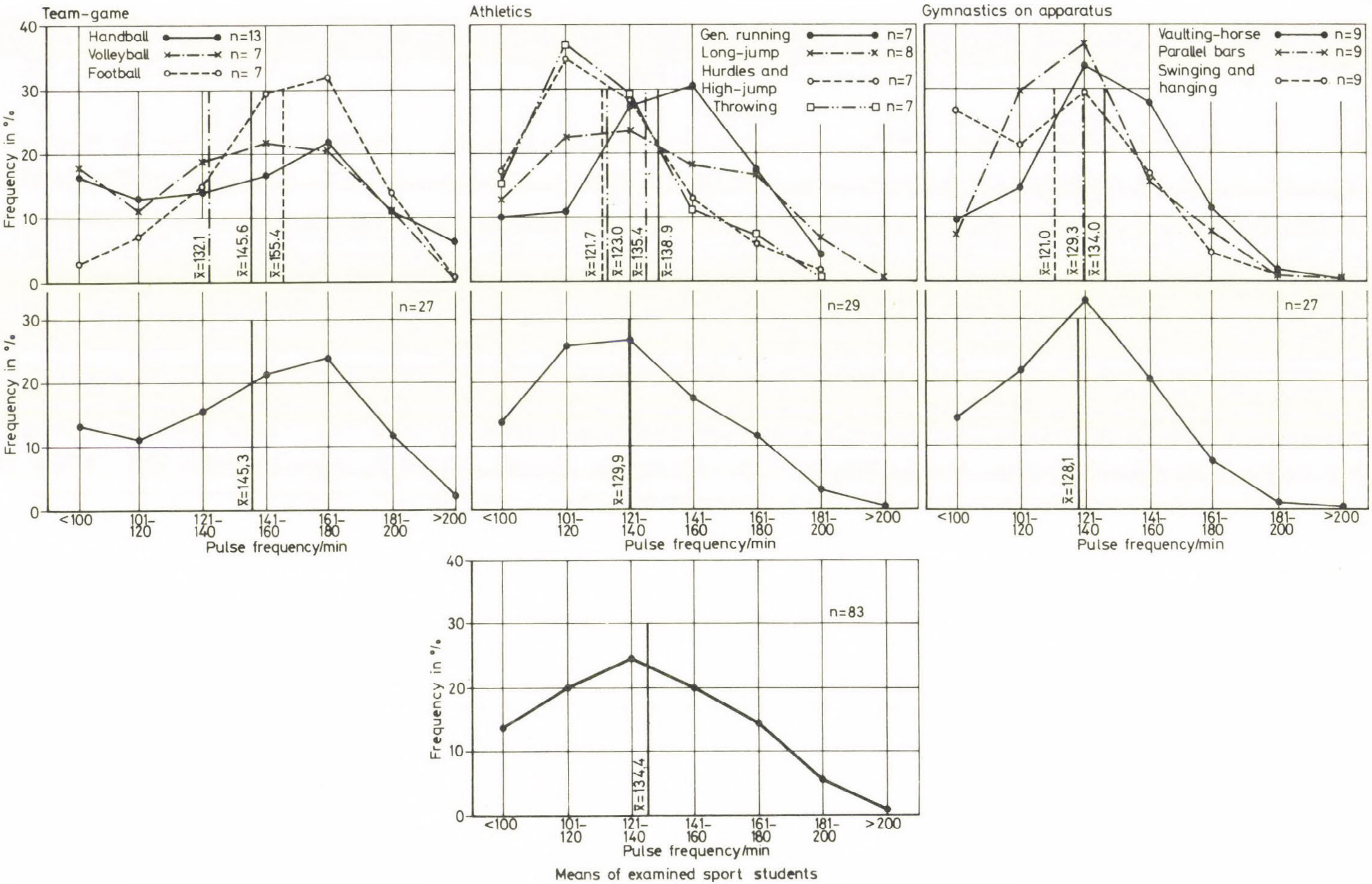
4 classes (26 - 31 pupils each) participated in this 10 weeks test-training once, twice, four times or six times per week respectively. The effect of our short training program(average values and standard deviation) and the particular parameters of evaluation are shown in fig. 4 . A direct relationship between training effect and training frequency is obvious. This dependence shows itself most clearly looking at the results concerning the carrying capacity of the heart-circulatory-system.

We were able to demonstrate that a 10 minutes-training-program raises the physical fitness. We suggested, therefore, to start each sport lesson with a systematic 10 minutes training . Quite independently of the further course and activity of such a sports lesson the aim to achieve maximum effectiveness or in other words fortifying one's physical fitness has been accomplished.



%
Loadability of circulation
Change related to starting-value
30
20
10
0
0
2
4
6
8
10
12
Months
SH
+++
++
−
Reaction ability
Change related to starting-value
+
Sport Class
Normal Class
Summer Holidays=SH

Figure 1



Team-game
Handball n=13
Volleyball n= 7
Football n= 7
x̄=132.1
x̄=145.6
x̄=155.4
Athletics
Gen. running n=7
Long-jump n=8
Hurdles and High-jump n=7
Throwing n=7
x̄=121.7
x̄=123.0
x̄=135.4
x̄=138.9
Gymnastics on apparatus
Vaulting-horse n=9
Parallel bars n=9
Swinging and hanging n=9
x̄=121.0
x̄=129.3
x̄=134.0
n=27
x̄=145,3
n=29
x̄=129,9
n=27
x̄=128,1
n=83
x̄=134,4
Frequency in %
Pulse frequency/min
<100
101–120
121–140
141–160
161–180
181–200
>200
0
10
20
30
40
Means of examined sport students

Figure 2

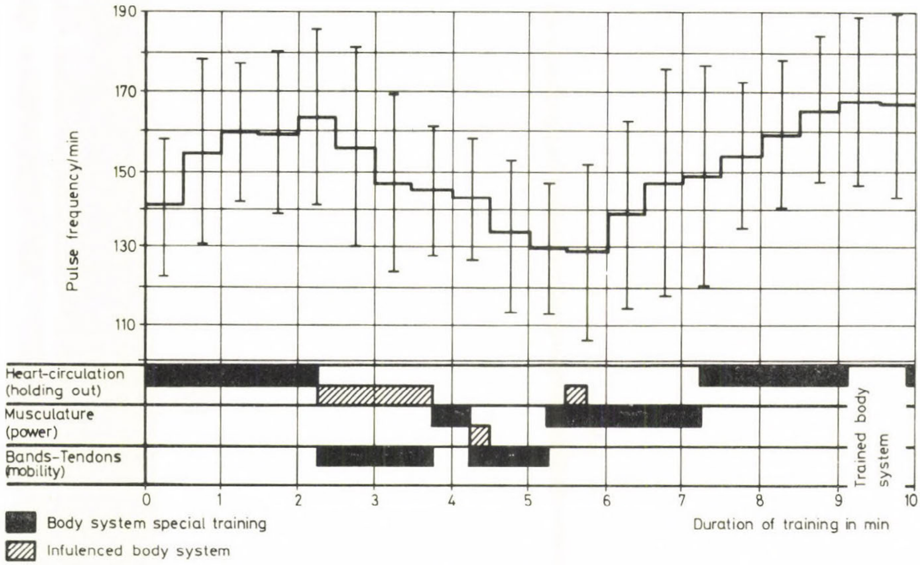


Figure 3

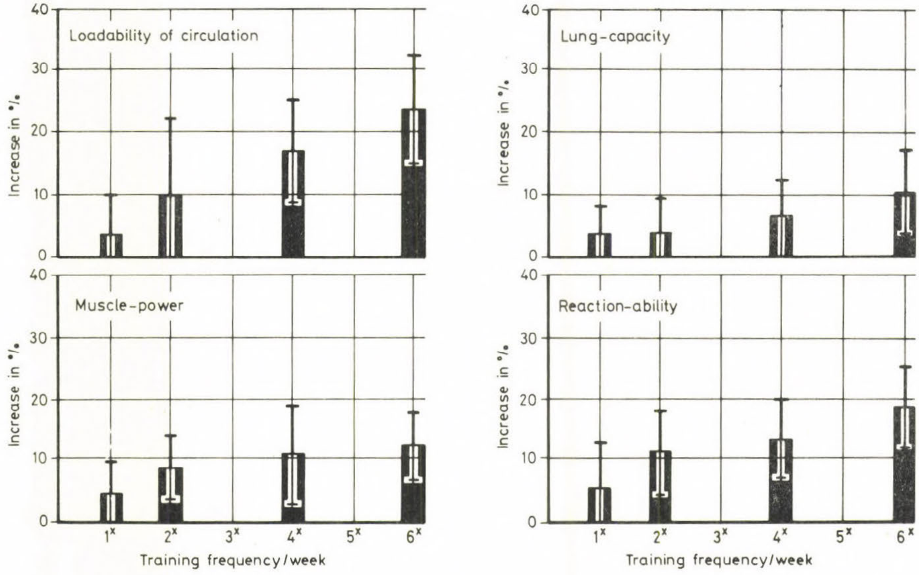


Figure 4

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INDICES OF PHYSIQUE AND MOTOR PERFORMANCE IN PUPILS ATTENDING SCHOOLS WITH A SPECIAL PHYSICAL EDUCATION CURRICULUM

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ABSTRACT

29 body dimensions, performance in 3 motor tests /6o-m dash, 4oo-m run and medicine-ball throw/ and 2 skills tests /wall volley and standing high jump with turn/ were recorded in 89 boys and 43 girls of 1o to 12 years. Estimates of bone weight and body fat per cent were calculated on the basis of bicondylar diameters, respectively skinfolds. The results are discussed in regard of the two sexes.

In the girls the linear and transversal body dimensions were related primarily to the 6o-m dash and the medicine-ball throw. Body fat was inversely related to speed in 4oo-m run. No other reliable connexion could be evidenced between test results and body dimensions.

In the boys the body dimensions correlated with medicine--ball throw and less closely with the wall volley. Significant inverse relationships were found between both running speeds and the sum of skinfolds.

Some of the body dimensions were analysed also according to Conrad's method. The distribution of the pupils' physique in the modified Conrad somatochart is also shown.

INTRODUCTION

Schools, respectively classes having a special curriculum constitute an integral part of the Hungarian system of education. In addition to special /extended/ curricula of natural sciences and languages, there are schools with specialization in physical education at places where material and personnel conditions are available. In these schools there are 6 curricular and 6 extracurricular classes per week, that is, twelve hours of physical education in the 4th grade. The purpose of the schools with a special physical education curriculum is twofold: 1. to promote a variegated and harmonious general development of the body, and 2. to provide a regular basis of athletic youth from which top sports will recruit their future ranks.

In one of these schools we compared some anthropometric parameters and motor performance in tests based on the natural movements of the male and female pupils of the 4th and 5th grades.

MATERIAL AND METHODS

In taking body dimensions the suggestions of the IBP were followed. The studied dimensions were 5 primary and 2 secondary measures of length, 6 breadths, 8 circumferences, 4 parameters of bone development and 4 skinfolds. The following motor tests were used: 6o-m dash, 4oo-m flat race, and medicine ball throw. Runs were performed according to athletic rules, times were measured to the nearest one-tenth second. For the ball throw a 3-kg medicine ball was used; it had to be thrown backwards. The best one of three trials was analysed.

Two skills tests were used: maximum angle of rotation of the body around the longitudinal axis after a vertical jump /jump and turn/ and wall volley. In the jump and turn test the best one of three trials was analysed. Turns were recorded to the nearest 3o degree. During the volley test the pupil standing behind a service line drawn at 4 m from the wall bounced the ball to achieve the greatest possible number of returns in 3o seconds. The ball was a regulation female handball.

The growth patterns of the pupils were estimated by the technique of Conrad /1963/. The point occupied by a subject in the Conrad somatochart consisting originally of 9x9 squares can be found by making use of two properties. Along the vertical axis the relative proportions of the body are plotted between the two extremes: leptomorphism and pyknomorphism. This property is called metric index /MEX/ by Conrad and it expresses the interrelations of stature, chest breadth and chest depth: elliptic or circular cross-section of the chest. Along the horizontal axis the measure of skeleto-muscular development /robustness/ is plotted. This is expressed in the form of a plastic index /PLX/ which is the sum of the biacromial distance /BIAC/, forearm circumference /FACF/ and hand circumference /HDCF/. The extremes in this index are hypoplasticity and hyperplasticity. The overall midpoint of the chart is designated as metromorphic-metroplastic.

The original chart of Conrad proved to be too small to plot little children and had to be proportionately extended. Details of the modifications, which allow also the use of basic statistics, will be treated by the co-author in another paper of this symposium.

Bone weight was calculated according to the formula of Enilina and Saksonov /1971/:

Bone weight $g = STA \cdot \overline{BCD}^2$, /Eq.1/

where STA is stature in cm, and $\overline{BCD}$ is bicondylar distance in cm at the distal ends of the long limbs, averaged over the four limbs.

In order to estimate relative body fat a regression equation based on Pařižková's tables /1960/ was used.

Means and standard deviations of the body dimensions and the performance test scores were calculated for both sexes. Connexions between the parameters of physique and the performance scores were studied by using product-moment correlation coefficients. In analysing the differences of the means for the two sexes and correlation coefficients we chose a 5 per cent level of random error.

RESULTS

The obtained data are tabulated /Tables 1, 2, and 3/. The modified Conrad somatochart and the respective group means of the boys and girls as well as the bidimensional

Table 1. Body measurements

Dimension	BOYS /n=89/ $\bar{x}$	SD	GIRLS /n=43/ $\bar{x}$	SD	t
Stature /STAT/	139,4	6,8	139,3	7,4	
Acromiale /ACHT/	113,5	6,7	112,6	7,1	
Dactylion /DACT/	51,8	4,6	51,7	3,9	
Iliospinale /ILSP/	78,5	5,4	78,6	5,o	
Sitting height /SIHT/	73,7	3,o	73,8	4,2	
Acrom.-dactyl. /ACDA/	34,9	4,6	34,o	3,1	
Acrom.-iliosp. /ACIS/	61,7	5,2	6o,9	4,1	
Biacromiale /BIAC/	3o,2	2,7	29,9	1,8	
Bideltoid /BIDE/	34,1	2,6	34,o	2,4	
Biiliocristale /BICR/	22,4	1,5	22,4	1,8	
Bitrochanteric /BITR/	24,5	1,7	24,3	2,o	
Chest breadth /CHBR/	22,4	2,1	22,3	1,7	
Chest depth /CHDP/	14,9	1,3	14,4	1,4	
Bicondyl.humer./BHUM/	5,8	o,4	5,5	o,3	4,36
Wrist diameter /WRIS/	4,7	o,3	4,6	o,3	
Bicondyl.femor./BFEM/	8,7	o,5	8,3	o,6	4,o3
Bimalleolar d. /BMAL/	6,4	o,4	6,1	o,3	4,36
Chest circf.insp./CCFI/	71,6	8,1	69,5	1o,8	
Chest circf.exp. /CCFE/	66,6	4,9	65,4	4,4	
Trochanter circf./TRCF/	71,4	5,6	7o,7	5,8	
Arm girth flexed /AGFL/	2o,1	2,3	19,9	2,o	
Forearm circf./FACF/	19,4	1,3	19,3	1,3	
Hand circf. /HDCF/	14,8	o,9	14,5	1,o	
Thigh circf. /THCF/	42,1	3,4	43,6	4,o	
Calf circf. /CACF/	27,9	2,4	28,7	2,4	
Biceps skinfold /BISF/	4,7	3,2	5,6	3,7	
Triceps skinf. /TRSF/	8,9	5,o	9,4	4,o	
Subscap. skinf. /SCSF/	5,7	3,8	5,9	2,7	
Sup.iliac skinf./SUSF/	8,1	3,8	8,4	4,7	

Table 2. Results of motor and skills tests, Conrad indices, body fat per cent and bone weight

Parameter	BOYS /n=89/ $\bar{x}$	SD	GIRLS /n=43/ $\bar{x}$	SD	t
60-m dash	10,5	0,8	10,8	0,9	
400-m run	102,2	14,8	101,3	9,8	
Medicine ball throw	508,0	107,0	449,4	89,8	3,10
Jump and turn	296,0	80,5	305,6	92,4	
Wall volley	24,4	5,2	24,6	3,7	
MEX /metric index/	-0,9	0,4	-1,3	0,4	
PLX /plastic index/	64,4	4,1	63,7	3,7	
Sum of 4 skinfolds	27,4	16,3	29,3	13,9	
Body fat per cent	13,2	6,5	14,6	5,5	
Bone weight kg	5,7	0,6	5,3	0,8	3,08

Table 3. Correlations of body dimensions and indices with motor performance

	BOYS / n = 89 / 60	400	Med	Turn	Vol	GIRLS / n = 43 / 60	400	Med	Turn	Vol
STAT	-.27	-.18	.46	-.10	.50	-.51	-.23	.41	-.02	.14
ACHT	-.24	-.21	.48	-.10	.44	-.49	-.17	.38	-.07	.05
ILSP	-.20	-.09	.45	-.11	.50	-.52	.24	.41	-.07	.13
BIAC	-.12	.22	.21	-.13	.16	-.61	-.32	.39	.05	.15
BIDE	.09	.22	.30	-.23	.20	-.42	-.03	.40	.02	.06
BICR	.11	.01	.30	-.20	.21	-.37	-.13	.21	-.03	-.09
BITR	-.05	.12	.31	-.14	.15	-.48	-.13	.30	-.05	-.02
CHBR	-.04	.11	.29	-.13	.17	-.21	-.14	.26	.24	.12
CHDP	.04	-.04	.25	-.12	.32	-.60	-.43	.46	-.03	.22
BHUM	-.06	.09	.42	-.02	.13	-.29	-.16	.23	.14	.15
WRIS	-.22	-.04	.53	.12	.27	-.36	-.43	.21	.16	.03
BFEM	-.06	.02	.35	-.16	.35	-.41	-.10	.23	-.08	-.06
BMAL	-.28	.12	.46	.00	.27	-.39	.07	.08	-.16	.03
S4SF	.49	.43	.02	-.25	-.06	.05	.40	.09	-.03	-.07
MEX	.19	.19	.00	-.08	-.07	-.21	-.24	.23	.19	.14
PLX	.19	.20	.38	-.11	.27	-.51	-.31	.35	.09	.14

standard deviations to express the variability of the groups are shown in Fig. 1.

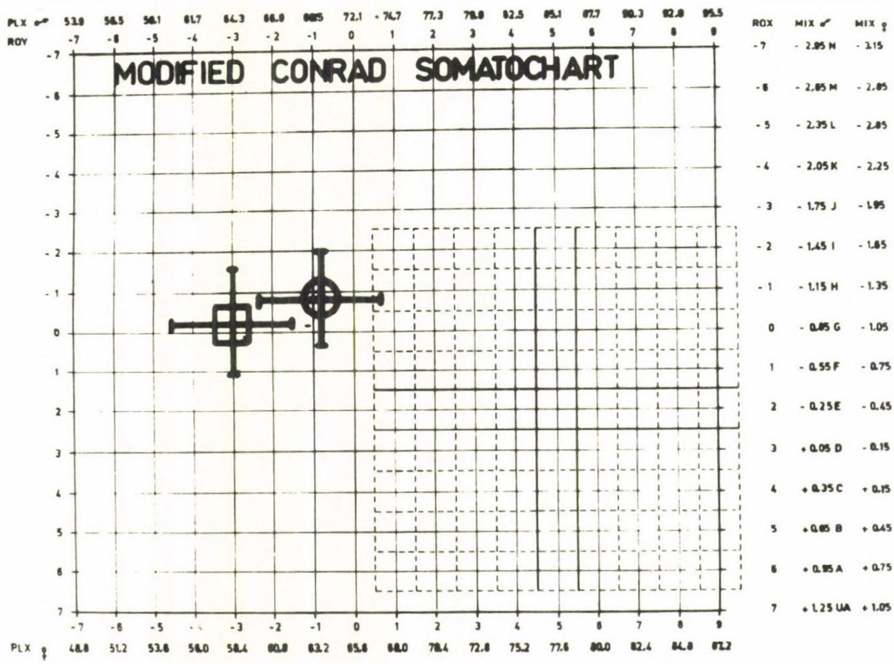

Fig. 1. Male and female means and standard deviations of the metric and plastic indices /MEX, PLX/ in 1o to 11 years old children attending a school having a special curriculum in physical education. The square designates the boys, the circle the girls. The dashed-line square shows the original chart used by Conrad /1963/. Numbers along the vertical and horizontal axes are the modified coordinates, respectively the male and female values for the metric and plastic indices.

DISCUSSION

As seen, statistically significant, but practically inappreciable differences exist in the biepicondylar widths of the humerus, femur and ankle as well as in the thigh circumference and bone weight. Only thigh circumference differed in favour of the girls.

In regard of the performance scores, the only significant and marked difference was found in the ball throw, in which the boys excelled by 58 cm.

The most interesting finding in respect of the correlations was that while 6o-m dash correlated well with several of the body dimensions of the girls, this relationship was missing in boys in whom only the sum of the measured skinfolds was significantly related to this motor test. The sum of the skinfolds did not show any similar connexion in the girls. Other similar contrasts were 1. that of the ball throw where biacromial and bideltoid distances only were significantly related to it in girls, but not in boys; and 2. that of the wall volley which did not show any connexion with the linear dimensions of the girls, but a rather close one in the boys.

The sum of the skinfolds, and so also estimated body fat, was inversely related to the speed of running 4oo m, in both sexes. The correlation of the plastic index with the performance scores was insignificant except for the 6o-m dash in the girls.

The comparison of the two sexes showed that at this age greater physical activity did not affect the almost identical rate of development. The distance between the respective means in the somatoplots stems from the sex-related difference of the plotting technique suggested by Conrad.

In absolute body dimensions the studied groups do not differ from either the Hungarian or the Belgian means of healthy subjects of the same age.

No essential difference was found between the respective performance scores of the two sexes either. The only exception was medicine-ball throw in which success requires strength, speed and motor coordination. The difference of more than o,5 metre may have arisen also from the slightly greater shoulder height of the boys.

Though we got many statistically significant correlations /altogether 68 for the boys and 39 for the girls/, acceptably close correlations could not be warranted by the mostly low coefficients. Ball throw, and for the girls the 6o-m dash are again exceptions which yielded higher coefficients with the linear, transversal dimensions and with the bone widths.

In summary, it may be stated that

-- four years of the special physical education curriculum and the increased physical activity implied by it yet failed to bring about appreciable changes in body dimensions when compared to the healthy standards of national and European origin;

-- of the motor test performances only those that require a maximum effort gave a sufficiently close correlation with the body dimensions.

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SOMATIC ASPECTS OF THE NYMEGEN GROWTH STUDY

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Abstract

The multidisciplinary, mixed-longitudinal Nymegen Growth Study[1] analyzes the interactions of various factors associated with development and growth in healthy Dutch children of 4-14 years of age. For each child numerous somatic, dental and psychological data were collected; while from their parents social background information was obtained. A computer system for data processing has been developed and includes facilities for data quality control and the generation of values to estimate missing data. The mixed-longitudinal design of data collection allows the estimating of and the correcting for disturbing cohort and time of measurement effects; this results in corrected and smoothed average growth curves. For the automatic calculation of individual growth velocities the original growth curves are smoothed. Growth velocity patterns, in combination with data on sexual development, supply base-line parameters for multidisciplinary studies of puberty. The Nymegen growth data have also been used for a discussion of the errors involved in the determination of the intersection of male and female growth curves or in the evaluation of the critical body weight hypothesis.

Introduction

Studies on growth of children usually concentrate on one or two aspects of the intricate processes of growth and development. A need was felt to combine information of several fields; this resulted in a multidisciplinary growth study by the University of Nymegen. During five years numerous somatic, dental and psychological data of Nymegen children were collected, as were social background information about the situation at home. To draw efficient and valid conclusions about so numerous and diverse variables, a scrupulous sample design is required, in combination with a well controlled data collection and a data processing system adapted to the study. While studying the somatic data it was found to be necessary to develop new statistical techniques or to modify already existing ones. Since the mentioned factors bear consequences on the final results, they will be discussed shortly below. Because during the time of the Hungarian Symposium on Growth numerous analyses of the Nymegen data are still in progress, only some first results will be presented.

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Methods and Results

The multidisciplinary Nymegen Growth Study was planned according a mixed-longitudinal design (Prahl-Andersen and Kowalski, 1973). Simultaneously, healthy Caucasian children of six different cohorts were followed in their development for a period of five years (1971-1975). The birth periods of the cohorts were chosen in such way that age overlaps occurred between preceding and following cohorts. Starting with children of approximately four, seven and nine years of age, growth can then be studied in children from four to fourteen years of age. All children within one cohort were born within a period of six weeks. Appointments were arranged so that the ages of all the children within a cohort at the time of their visit were within a few days of each other. Children younger than nine years were examined twice a year, and those of nine years and older four times a year. This design required twenty periods of observation, each lasting two months.

To obtain the required sample, out of a list supplied by the registry-office of all children born in the chosen six birth periods in Nymegen, a middle sized Dutch town, a random sample of 900 children was drawn. About half of their parents was willing to let their child participate in the Growth Study. Comparison of the non-participants with these participants revealed that relatively more parents from low socio-economic level refused to cooperate. After pilot studies in 1970 the study started in January 1971, with a total of 486 children, 232 boys and 254 girls. The final drop-out was no more than 12.5 per cent, primarily due to emmigration from Nymegen. During the Study the children were given dental treatment when needed, while their parents were free to consult either the physician or the psychologist of the Growth team concerning their child.

At each visit, for each child information about 170 dental, somatic and psychological variables was collected and stored on file at the Nymegen Computer Center. Psychological investigations included measuring of cognitive functions (such as verbal learning, perception, and abstract reasoning), the child's personality (such as need for achievement, extraversion) and school achievement (mechanical reading, reading comprehension and arithmetic ability). By visiting the parents at home inquiries were made concerning social background, attitudes of father and mother concerning education at home and at school, medical and social attitudes (e.g. anomy, disintegration) as well as attitudes with respect to relations within the family. These data were used to define new criteria for the evaluation of the social environment at home which are perhaps more relevant than the commonly used parameters such as socio-economical status of the father.

The somatic investigation of the child included caries registration. Impressions of both dental arches and X-rays of the head, dentition and the left lower arm and hand were made to enable functional analysis of the jaws, and recording of dental and skeletal age, respectively. Blood samples were taken to acquire information on hemoglobin, hematocrit, gammoglobuline and gonadotrophins values. Additionally, at the beginning, mid-period, and end of the study somatotyp-photo's were taken. During a general examination by the physician sexual development (pubic hair stage, size of breasts or penis and testicles) was rated according the Tanner scales (Tanner 1962). Ages of menarche were obtained by quaterly inquiries. Furthermore, fifteen anthropometric variables were measured during each visit, with instruments having an automatic read-out (Prahl-Andersen et al., 1972). Advantages of this equipment include a reduction in manpower, a saving in time, and elimination of errors due to visual reading, coding, or punching. The variables included height, weight, sitting height, biacromial and biiliacristal diameter, bicondular femur and humerus, circumferences of upper and fore arm and head, four skinfold thicknesses and handgrip force.

Longitudinal analyses require a high data quality; the study of changes by time is only relevant when these values are not surpassed by values of errors of either technical or biological origin. Fortunately, longitudinal series of data offer special possibilities of data quality control. Regression analyses, outlier tests and inconsistency checks were performed as data quality control techniques. Correction may be made by omitting, reconstructing, or remeasuring values (if possible). A next step was the generation of values to estimate missing data. Since a number of statistical tests require a complete data set, two sets of data are stored on file: one contains the original data, while the other contains a complete set with additional, generated values.

As mentioned, the data were collected according a mixed-longitudinal design. Note, that in the Nymegen Growth Study this does not refer to a longitudinal study of children from one single birth period group in which subjects are replaced by others of the same cohort during the course of the study. We collected data on children of different cohorts, and followed the cohorts simultaneously in their development (without replacements). This has as a consequence that to analyze growth in children of 4-14 years, data will have to be combined of children born 2, 3 or 5 years apart. Though indications have been given that in western countries the effect of the secular trend is slowing down (e.g. Ljung et al., 1974), it was felt to be necessary to check the validity of the data with respect to cohort effects. Moreover, one should be aware of the fact that systematical observer effects (time of measurement effects) and test effects may be confounded in the data. Until now, it proved hard to evaluate the impact of these sources of bias. A mixed-longitudinal design however, allows to estimate and correct for disturbing cohort and time of measurement effects. The statistical model employed has been described elsewhere (Van 't Hof et al.); it is a modification of the method introduced by Schaie (1965), then applied on psychological data. Using this model, average growth curves for the various anthropometric variables were constructed. In addition, a special analysis was developed to calculate the standard deviations of these curves, based on data of overlapping cohorts. The construction of the smoothed average growth curves did not reveal significant cohort differences for height and weight. This supports the finding by Pieters (1973) that the secular trend in Holland is less pronounced during recent years. Results of the analyses of some of the quantities, however, did indicate that one should stay alert for biasing effects due to differences in birth period and time of measurement errors (Roede and Van 't Hof).

One of the base-line parameters for multidisciplinary analyses is growth velocity. There are several methods to define and calculate growth velocity, yet, these were considered not appropriate for our data. A troublesome point of the increment method is the fact that a relatively high observation frequency (e.g. four times a year) does not imply an increase in the precision of the estimation of individual velocities, but results in a relatively smaller accuracy of the calculated velocities. This is explained by the fact that with a high observation frequency the magnitudes of the associated changes are necessarily smaller, while the magnitudes of the measurement errors are unchanged. The main drawback of a logistic curve fitting is the fact that data must cover a sufficiently long time period to allow accurate determinations of the upper and lower asymptotes of the S-shaped functions of these curve fittings. Series of data covering five years do not meet these requirements. A solution was found by fitting moving parabolas to the data over a period of one year. This "yearly parabola method" (Van 't Hof et al., 1976) proved to produce a better impression of the biological reality than the increment method.

Puberty is also an important item in comparative studies. It is difficult, however, to formulate valid criteria to define the start of puberty and the overall degree of sexual development. An analysis of puberty patterns of late and early, and fast and slow maturers will be attempted by combining data on sexual development and growth spurts.

Growth data, once they are stored in a computer, can also be used for answering secondary problems. For instance, a stochastic computer simulation technique (Monte Carlo) was applied to the Nymegen Growth data to determine the errors involved in the estimation of ages of intersection of male and female growth curves during puberty (due to the earlier growth spurts of girls as compared to boys of the same age) (Roede and Van 't Hof).

Moreover, correlations of the values of several somatic quantities at menarche with the age at menarche, could be compared with correlations in a simulated study in which the age of menarche was randomly redistributed over the post-menarchal Nymegen girls (Monte Carlo technique). The results, revealing no specificity of weight as compared to height, do not support the critical body weight hypothesis by Frisch and Revelle (1970) (Van 't Hof and Roede).

This survey suggests how the data and the analyses system offer diverse possibilities for studies on the somatic aspects of the Nymegen Growth Study.

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DYNAMICS OF GROWTH AND MATURATION IN NORMAL SHORT BOYS

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ABSTRACT

The authors analyzed growth and maturation of 111 Warsaw boys of 11 to 14 years old, with no evidence of organic diseases, who in prepubescence period attained body height between 25 and 3 centiles according to the charts prepared by Brzezinski and Kopczynska-Sikorska. At birth, as far as body-length and weight were concerned, they did not differ from normal Warsaw new-borns. Parental body height of the boys with the shortest stature was evidently lower from the mean data of local standards.

Up to the 18th year of life stature, weight, secondary sex character, and skeletal age were estimated and evaluated at 3 or 6 months intervals.

In the boys under investigations their own growth dynamic track was observed. The differences in stature in prepubescent period were the same until 18th year of life, in spite of different calendar age of the start in successive stadia of sexual maturation and in spite of the differences in skeletal maturation level.

INTRODUCTION

The course of normal child growth and maturation with hypostature, particularly in the second decade of life, is the subject which in spite of considerable practical importance has scant data. From recent literature the most valuable ones are the works of Lacey and Parkin /1974/ as well as of Tanner and coll. /Tanner 1962, 1969, Tanner and Whitehouse 1976, Mashall and Tanner 1970/. The opinions on the relationships between growth and maturation of normal short children are often controversial to a certain degree. It particularly refers to prognosis of the adult stature and to medical treatment and supervision.

Moreover, as our long experience indicates the boys, mainly in the second decade of life, may have some emotional disturbances being the cause of psychosocial problems, so-called somatic dismorphophobia.

In connection with the above and owing to the fact that the incidence of this condition is about 5-10% of population in the age of development it seemed necessary to study the rate of growth curve until the end of pubertal maturation in the boys with different degrees of hypostature. This paper analyzes the dynamics of development in the second decade of life in normal boys before puberty with different degrees of hypostature. We are specially interested in the sequence and tempo of somatic changes and their influence upon the stature after reaching stage V of sexual maturation.

MATERIAL AND METHODS

The group of 111 school-boys was studied longitudinally, in the Growth Control Outpatient Department /1962-1970/. The boys suffered from short stature, but the pituitary, metabolic, chromosomal and nervous system defects were not stated and they were diagnosed as hypostatura simplex of different intensity. Their body length and weight at birth were within the normal range and skeletal age during growth showed different degrees of retardation. They were not treated with hormones.

The group of boys under study, due to their hypostature, is conventionally identified by reference to their centile position using normal standards on Warsaw centile chart prepared by Brzeziński and Kopczyńska-Sikorska /1965/. Relying on these standards the boys were divided into three groups:

Group 1 of 31 boys with the lowest stature, the initial stature was on 3rd centile or below but with a linear growth velocity within the lowest limit of the normal range.

Group 2 of 50 boys with low stature, the initial stature was on 10th centile of chart or below.

Group 3 of 20 boys, body height was on 25 centile of the chart or below, with retarded skeletal maturation with more than 2 consecutive standards for chronological age.

Auxological observations of the events were carried out in three or six-month interwals over six years and they concerned height and weight puberty stage in Tanner scale on the basis of the evaluation of genital development /Marshall and Tanner 1970, Tanner and Whitehouse 1976/, skeletal age on the basis of atlas methods of Kopczyńska-Sikorska /1969/ in yearly intervals.

In the studies the information on birth body length and weight, and the growth rate in the first decade of life were taken into consideration. Apart from evaluating the parents stature, the socio-economic status of the parents was evaluated on the basis of educational level. The data collected were statistically evaluated in the above three groups of boys. Mean arithmetical calues of height and weight, skeletal age, age of reaching consecutive stages of puberty and height and weight reached in the stages from II to V were estimated in yearly intervals. Also mean arithmetical values for stature of mother and father of the three groups of boys were evaluated.

RESULTS

The frequency of endocrinological conditions causing hypostature constitute a small percentage of children /Lacey and Parkin 1974, Marshall and Tanner 1970/. Newertheless, genetic and environmental investigations show that heredity of short stature, and poor home conditions, and social environment have an essential influence upon the realization of growth potential /Acheson 1957, Brzeziński and Kopczyńska-Sikorska 1964, 1965, Tanner 1962, 1969/.

The differences between adolescents in adult size and shape are due to differences in their gene pools, in their environment and in the interactions between these two /Tanner 1969, Tanner and Whitehouse 1976/.

In Fig. 1 the means of mother's and father's stature is presented.

The stature of the mothers and fathers of boys from the 1st group was the lowest. They are below the mean standard for Polish population. Chi^2-test analysis showed a strong association between the short stature of mothers and hypostature of the boys under study.

The comparative analysis of the social status showed that the parents with university education were represented to a minimal degree in group 1 and to the maximal percentage in group 3.

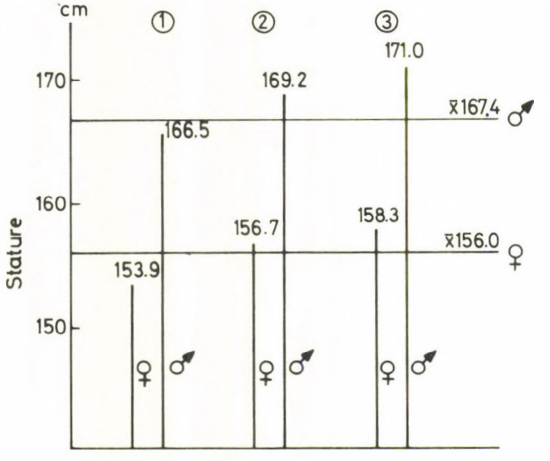

Fig. 1. Characteristics of mother's and father's stature of three groups of boys under study

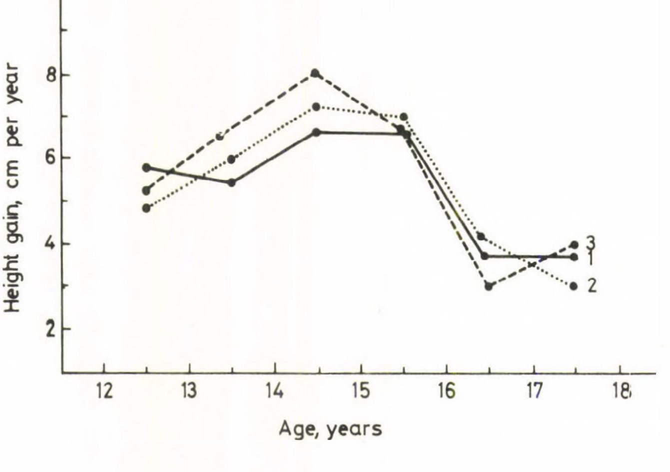

Fig. 2. Velocity curves of boy's height from three study groups

Acceleration of the intensity of growth and maturation events is typical for the second decade of life. The children differ a great deal in the age at which they begin their puberty. It causes real difficulties in growth diagnosis which in practice quite often leads to "underdiagnosis" or "hyperdiagnosis" in short stature children. In spite of constant progress in diagnostic methods somatometric criteria do not lose their practical value.

Velocity curves of yearly increase in height of three analyzed groups of boys are presented in Fig. 2.

The lowest height increase was observed in the 1st group of boys, the highest in the 3rd. This regularity tock place until 16 years of age when the most typical character of the curve was represented by group 2. It should be noted that deceleration of growth velocity takes placed before growth spurt, having its peak at the age cf 13.5 years. Also their peak growth velocity spurt is the lowest in boys under study.

Fig. 3 presents the mean calendar and skeletal age on reaching the consecutive stages of pubertal events, and shows, that group 3 started puberty, second stage early, i.e. at the age of 14, the latest were the shortest boys at the age of 14.8 years.

This regularity was observed in the course of development of consecutive stages cf sexual development not only for calendar age but also with certain delay in the category of skeletal age. In all boys at each consecutive stage the skeletal age varies much less in relation to chronological age. The differences in the age of appearance of consecutive stages in each of the three groups show disappearing tendency reaching the lowest values in categories of skeletal age in stage V of sexual maturation.

The differences between chronological and skeletal age in every analyzed stage of sexual maturation of these boys is illustrated in detail in Fig. 4.

The highest delay of skeletal age is observed in the first two stages. In stages IV and V of sexual development it decreases and in stage IV the difference amounts to 1.6 in V, however, only 1 year.

Figure 5 presents body height and weight means obtained in the consecutive stages of sexual maturation.

In group 3 of boys the highest stature and body weight was observed in all consecutive stages of sexual development.

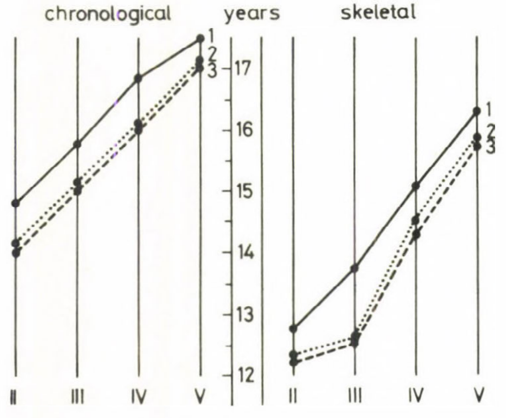

Fig. 3. Age on reaching each puberty stage of sexual development according to chronological and skeletal age in three groups of boys

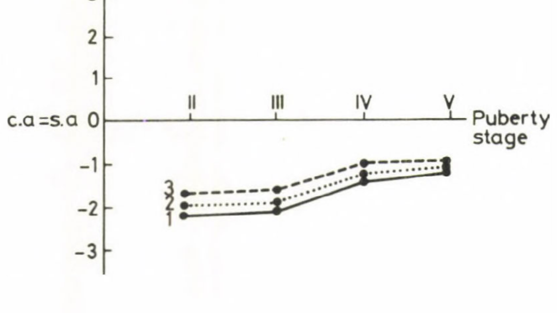

Fig. 4. The differences between the chronological and skeletal age at the corresponding puberty stage of three groups of boys

Table 1 Mean values for body height /cm/, weight /kg/ chronological and skeletal ages /years/ on reaching each pubertal stage of three groups of boys

Groups of boys	Analyzed features	Pubertal stage II	III	IV	V
1	height /cm/	147.1	154.5	160.1	162.5
	weight /kg/	38.0	44.9	50.0	52.8
N = 41	calculated age	14.70	15.90	16.70	17.47
	skeletal age	12.60	13.90	15.10	16.40
2	height /cm/	149.7	155.4	161.3	164.3
	weight /kg/	37.1	44.2	50.8	54.0
N = 50	calculated age	14.20	15.00	16.10	17.20
	skeletal age	12.30	13.20	14.70	16.00
3	height /cm/	153.5	160.5	166.1	169.0
	weight /kg/	41.0	47.0	51.0	56.0
N = 20	calculated age	14.01	15.02	16.02	17.03
	skeletal age	12.30	13.50	14.30	16.00

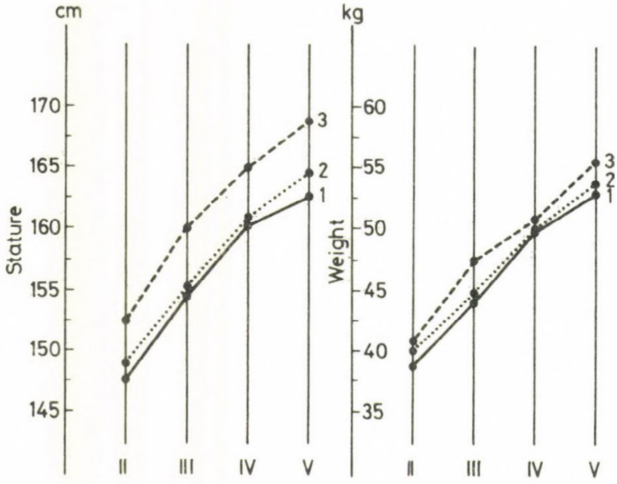

Fig. 5. Body height and weight on reaching consecutive pubertal stage in three groups of boys

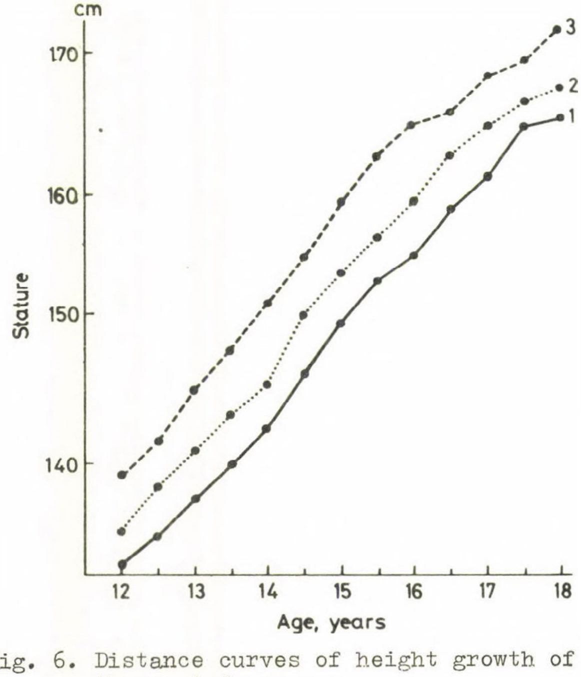

Fig. 6. Distance curves of height growth of boys from three study groups

Therefore, it results from the investigation that growth of the boys from three selected groups goes their own way and the differences in height observed in prepubescent period at the age of 12 years last until 18 years of age in spite of different age of sexual maturation which is illustrated in Fig. 6 and Table 1.

SUMMARY

As the result of growth rate analysis and maturation of boys with different degrees of height defficiency registered in prepubescent stage up to adolescent period and appearing in stage V of sexual development it was stated that:

1. In the sons of the parents who had the shortest stature especially mothers, the puberty starts with low stature and later than in the other boys of the same age. In spite of the retarded skeletal age they have small chance to catch up growth curve because in the course of development the differences between the calendar and skeletal ages tend to disappear.
2. Differences in height and weight occurring before pubescent period exist in all boys after stage V of sexual maturation.
3. A group of the shortest boys enters the puberty period at the latest calendar and skeletal age and this is also observed for all consecutive stages of sexual development.
4. The age of reaching the analyzed stages of sexual maturation varies in the three groups of boys under study in regard to calendar and skeletal age. The differences are the greatest between the 1st and 3rd group.
5. The 3rd group of boys /the tallest/ have the highest growth dynamics and the highest peak height velocity in pubertal spurt and are the earliest maturers among these boys.

It seems that the observed results may be the evidence of the independence of the mechanism responsible for the events of growth and maturation which is in agreement with other authors /Tanner 1974/.

In order to verify the above results not only for cognitive reasons but also for monitoring progressive studies for hypostature children are planned including the youngest as well as the oldest groups of age.

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PATTERNS OF GROWTH AND DEVELOPMENT IN EUROPEAN AND MONGOLOID CHILDREN FROM BIRTH TO 7 YEARS OF AGE
(Preliminary data)

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In 1973-74 five thousand European /Russian, Moscow/ and Mongoloid /Kazakhs and Kirghizes/ children from birth to 7 years of age were examined.

Kazakhs and Kirghizes according to the classification accepted by the Soviet investigators belong to the South-Siberian race in which a considerable admixture of ancient European elements is marked /Kazakhs are more Europoid than Kirghizes/.

The material was analyzed according to the age groups with three months' interval from birth to 3 years and with six months' interval after 3 years.

The body length from birth to 7 years in Russian children of both sexes increases by 71-72 cm and in Mongoloids by 69-73 cm. Russians are 1.5-3 cm taller than Kazakhs and 2-4 cm taller than Kirghizes.

Russian and Kirghizian boys are on the average taller than girls until 6.5 years, henceforth girls surpass boys. As for Kazakhs, boys are taller than girls in all age groups. Evidently they have the first growth change after 7 years.

The maximum intensity of growth rate of body length in Russian children is marked from birth to one year, then the tempo of growth decreases and after 3 years it increases somewhat again.

One can see a relatively even rate of growth in the Mongoloid groups, only for a period from 2 to 2.5 years the intensity of growth reduces insignificantly. Apparently, it may be brought about by the common effect of endogenous and exogenous factors.

From the features characterizing morphological differentiation of the organism the body weight is of great importance. In Russian children, both weight and stature are greater than in Mongoloid ones. Kazakhs on the average weigh 300-800 g less than Russians, and Kirghizes weigh 500-1500 g less than Russians. These differences are statistically significant in most age groups.

The sex differences in weight are the greatest at the age of 7. The weight of Kazakh girls is 640 g more than that of boys and the weight of Kirghizian girls is 400 g more. As for Russian girls at the age of 7 they are 330 g less than boys. It may be noted that sex dimorphism in body weight is more expressed in the Mongoloids.

Index of growth conformity between stature and weight /calculated according to V.V. Bunak/ showed that in both sexes there was an equivalent trend. In Russian children from birth to 4 years a relatively greater rate of growth was observed in body length. After 4 years of age growth rates of both features are almost the same in girls. As for boys their weight increases more considerably than their stature. As far as the Mongoloid group is concerned both sexes have the same relationships as Russian boys have.

To explain these facts one should consider the possible role of the physical activity of children. The level of physical activity must correspond to the children's age to support a harmonic physical development. Hence it can be supposed that in the period of the first childhood a considerable accumulation of weight in Russian boys and in Mongoloid children may be caused by much more energetic supply that is connected with intensified motor activity.

In addition to observed characteristics we measured subcutaneous fat as an index of development. We measured skinfolds on four sites /under the scapula, over the triceps, on the abdomen and on the thigh/. We used the sum of skinfolds. The analysis of this index showed that there was no essential difference between the two ethnical groups though the Russians had a slight tendency towards more adiposity.

Calculated values of body surface are greater in Russians than in Mongoloids. For example: the body surface in 7-year old Russian boys in 0.9281 m^2, in Kazakh boys of the same age - 0.8892 m^2, in Kirghizian boys - 0.8728 m^2. Corresponding figures for girls at the age of 7 are 0.9175 m^2, 0.9002 m^2 and 0.9000 m^2 respectively.

The results of the investigation showed that patterns of growth and development in the compared ethno-racial groups were slightly different. The explanation of the causes of these differences require further research and deeper analysis of the combined effect of endogenous and exogenous factors.

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SOME ASPECTS OF GROWTH IN SPANISH CHILDREN

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ABSTRACT

We have recorded a sample of about 2.000 children, aged 6-17, all of them belonging to the intellectual upper stratum in Madrid. Weight and height of each child has been recorded for several years /a minimum of 5 and a maximum of 10 years/, and with these measures we studied: /1/ Mean weight and height for each age group; /2/ Variation of weight and height in relation to the month of birth; /3/ Variation of weight and height with parity.

Results are compared with other samples of Spanish population, in order to analyze the Spanish secular trend in physical growth, and the variations due to socio-economic status.

INTRODUCTION

Growth and development are the result of genetics and environment. The main environmental factors affecting growth are the complex interaction of living conditions. So rural ecology and urban ecology give different patterns for physical development and adult physical constitution. Usually rural populations show poor nutrition and a low sanitary level, high frequency of endogamous mating, and an early age when starting work. In the past 10,000 years, human populations have remained mainly rural. From 1900 onwards a transcendental change has taken place in the ecology of human populations, as they became mainly urban. As a result of this, nutrition and welfare have experienced important improvements, exogamous matings have rapidly increased, and the age of starting work has been delayed. These circumstances are known to have a favourable influence in growth, and they are considered to be the main causes for the secular trend in growth /Valatowsky 1966, Takahashie 1968, Schreider 1968, Wolański 1974/.

We analyze here the effect of the month of birth, birth order and family size on the physical development of Spanish children. We also discuss the influence these factors could have on the secular trend in Spain, where urbanization with all its ecological consequences is a recent event.

MATERIAL AND METHODS

Weight and height data of 882 children aged 10 to 17 have been collected. For each child we recorded: birth date, birth order, family size, parents' place of birth, weight and height over several consecutive years, which vary from 5 years in boys aged 10 /from 6-10/, to 12 years in boys aged 17 /from 6-17/. With these data we analyzed:

1. The effect of the date of birth on physical development /weight and height/. The 6314 available data were grouped in three-month periods. Comparisons were made by using the T-test.
2. The effect of birth order on physical development. Boys were classified according to their order of birth following categories: parity 1, parity 2, parities 3 and 4, and parity 5 or subsequent ones. For this end we present over 7392 data.
3. The effect of family size on physical growth. Data were ordered to compare growth of boys whithin the same parity, but belonging to different family size.
4. The effect of secular trend in Spain.

The sample is representative of the high socio-economic status of Madrid. Most of the boys came from exogamous matings, and had habitual physical training at school.

RESULTS

1. Effect of the date of birth on height and weight development

As it is logically expected, there is a slow decrease in physical development as children are born later on in the year /Tables 1 and 2/. Boys born during the first 6 months of the year are taller and heavier than those born during the second half of the year. Differences are significant for all ages but 17, between boys born from January to March, and those born from October to December.

2. Effect of birth order on height and weight development

Table 3 shows the reduction of longitudinal growth as parity increases. Between parities 1 and 2, differences are not significant. Boys belonging to parity 5 and subsequent ones are about 2 cm shorter than the first-borns along all the ages studied, the differences are statistically significant corresponding with other results /Prokopec 1969, Olivier 1974/. Table 4 shows the diminution of ponderal growth as parity increases.

3. The effect of family size on heigth and weigth development

Some authors /Olivier 1974/, have found that in adult populations, the individuals from big families are about 2 cm shorter the those from small families, all of them having the same birth order. Table 5 shows differences in growth of children with the same birth order /parities 1 and 2/, but with different family size /sizes 1 and 2, and 3 and subsequent ones. In our sample differences in growth became patent only from 14 years onwards.

4. The effect of secular trend in Spain

In Spain, as in many other countries, secular trend in growth have manifested throughout this century. In 1900, young men were 163.5 cm tall, and weighed 63.85 kg. In 1967, they are 168.1 cm tall, and weigh 65.5 kg. Table 6 shows several samples of Spanish populations that suggest secular trend in growth. Growth differences among different Spanish populations due both to their geographical origin and to the socio-economic status can also be seen. Our 17 years old children, whose growth has not yet been completed, are about 2.5 cm taller than the recruits, which is a consequence of the two points mentioned: the recruits come from every Spanish

Table 1

Effect of the date of birth on height development

Month of birth / age /years/	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
7	122.53 4.47	122.07 4.70	120.79 4.35	119.75 5.22
8	127.11 4.77	127.25 5.19	126.18 5.22	124.83 5.11
9	132.61 5.44	131.80 5.29	131.14 4.92	129.78 5.46
10	137.33 5.66	136.57 5.51	136.11 5.76	134.95 5.60
11	141.75 6.17	141.03 6.01	140.37 5.70	139.51 6.36
12	146.37 6.28	145.47 6.42	145.09 5.94	144.02 6.40
13	151.79 7.23	150.89 7.33	150.10 6.52	148.63 7.28
14	158.26 8.18	157.00 7.98	156.07 7.43	153.85 8.09
15	164.01 8.83	163.37 8.01	162.83 8.19	160.23 8.35
16	168.11 8.45	168.62 6.97	167.88 7.50	166.55 7.50
17	171.52 6.65	171.84 5.96	170.18 6.48	169.72 5.70
N	1528	1701	1454	1555

Table 2

Effect of the date of birth on weight development

Month of birth / age /years/	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
7	23.82 2.98	23.22 2.57	23.91 3.25	22.45 3.51
8	26.61 3.55	26.28 3.76	26.45 3.69	25.43 4.06
9	29.60 4.31	28.82 3.72	29.27 4.50	28.51 5.22
10	32.77 5.26	31.87 4.65	32.44 4.87	31.03 6.95
11	35.80 6.01	34.78 5.37	35.14 6.70	34.82 6.70
12	39.52 7.22	37.89 6.28	38.63 6.15	37.86 8.24
13	43.98 8.26	42.07 7.43	42.31 7.63	41.73 8.57
14	49.18 8.91	46.47 8.62	47.15 8.53	46.12 9.16
15	54.26 10.16	52.33 8.86	53.41 9.01	51.72 10.80
16	58.58 10.95	57.84 8.63	57.77 8.85	56.86 11.53
17	62.02 10.44	61.38 7.54	59.87 7.91	59.47 10.56

Table 3

The effect of birth order in height development

Parity / age /years/	1	2	3 and 4	5 and subseq.	Total
6	117.44 5.87	116.27 5.16	116.00 5.69	116.53 5.71	116.74 5.46
7	112.82 5.24	121.67 4.79	121.41 4.78	120.39 4.89	121.63 4.93
8	127.36 5.17	126.80 5.03	126.37 4.89	125.68 5.44	126.63 5.12
9	132.04 5.49	131.57 5.37	131.24 5.21	130.49 6.16	131.48 5.48
10	136.88 5.64	136.12 8.93	135.60 5.34	134.91 6.21	135.99 7.04
11	141.19 6.24	140.93 5.84	139.97 5.59	139.11 6.63	140.47 6.08
12	145.59 10.34	145.63 6.14	144.31 5.90	143.56 6.73	145.11 6.46
13	151.06 7.50	150.91 7.23	149.02 6.73	149.01 7.89	150.00 7.37
14	157.17 8.18	157.27 7.91	154.40 8.80	154.54 8.71	155.85 8.23
15	163.44 8.60	163.44 8.15	161.13 8.32	160.11 8.64	162.03 8.43
16	168.83 7.66	168.76 7.35	166.25 7.35	165.71 8.44	167.39 7.70
17	171.33 6.31	170.19 6.50	170.67 6.07	169.25 5.83	170.60 6.28
N	2382	1823	2054	1183	7388

Table 4

The effect of birth order in weight development

age /years/ \ Parity	1	2	3 and 4	5 and subseq.	Total
6	22.24 2.51	22.14 2.64	22.66 3.01	22.32 3.62	22.37 2.86
7	24.46 3.15	24.21 3.10	23.88 3.03	22.93 2.99	23.90 3.10
8	26.79 3.89	26.46 3.94	26.31 3.54	25.83 3.50	26.35 3.74
9	29.63 8.10	29.20 4.45	28.88 4.19	28.39 4.28	29.03 5.26
10	32.49 5.71	32.50 4.81	31.33 4.44	31.29 5.79	31.90 5.20
11	35.42 5.89	35.55 5.47	33.83 5.92	34.05 6.67	34.71 5.84
12	38.93 7.33	39.41 6.72	37.00 6.21	37.75 6.84	38.27 6.78
13	42.86 8.22	43.13 7.60	40.81 7.75	42.17 8.28	42.24 7.96
14	47.70 9.35	47.90 8.79	45.94 8.38	46.30 9.43	46.96 8.99
15	53.16 10.31	53.93 8.95	51.13 9.93	50.83 9.74	52.50 9.73
16	58.49 10.56	58.90 8.82	56.23 8.81	54.36 10.36	57.60 9.64
17	61.75 9.56	59.60 7.35	60.57 9.92	57.45 8.25	59.84 8.77

Table 5

The effect of family size on height development

age /years/	Family size 1-2	Family size 3 and subsequents
7	122.27 4.41	122.78
8	127.38 4.79	127.36
9	132.07 5.17	132.08
10	136.79 5.21	136.91
11	141.02 5.27	141.34
12	145.92 6.47	146.24
13	151.07 7.35	151.29
14	157.48 8.18	156.95
15	164.65 8.71	162.66
16	169.24 7.42	168.54
17	172.20 7.00	170.30

Table 6

Data to the secular trend in Spain

Age /years/	Madrid 1895	Madrid 1968	Madrid 1976	Barcelona 1944-45	Asturias 1946 Mieres	Asturias 1975 Oviedo	Andalucia 1945 Granada	Andalucia 1945 Malaga
6			116.74		106.6	114.33		
7		120.20	121.63	121.22	112.7	121.86		
8		125.09	126.63	126.95	116.0	125.97		
9		130.71	131.48	131.37	121.2	130.34		
10	126.1	135.77	135.99	137.19	126.6	136.99	128.8	
11	128.7	140.29	140.47	140.88	129.8	140.90	132.2	131.0
12	132.2	145.23	145.11	145.85	133.6	145.97	135.8	135.9
13	137.8	147.95	150.00	150.76	139.2	150.99	139.8	140.3
14	145.6	154.37	155.85	156.28	145.0	158.71	143.8	148.8
15	149.9	161.89	162.03		152.1	163.87	152.2	156.0
16	155.8		167.39		159.0		158.0	159.4
17	160.8		170.60		163.7		160.7	163.3
18	162.1				164.7		164.8	164.7
19	162.9				166.1		165.7	166.3

populations and from every socio-economic status, while our sample comes from the upper socio-economic status of Madrid.

DISCUSSION

Growth patterns as to the month of birth show differences between children born during the first month of the year, and those born during the last ones. It would be natural enough to think that the former ones would complete their growing later, reaching ultimately similar heigths; but the only paper which, as far as we know, has dealt with this problem, shows that there is not such a height overtaking /Breitinger 1972/. It would be interesting to check if monthly frequencies of births are the same for rural and urban environments, because if rural populations would show greater frequencies of births during the last months of the year, this could be another reason to account for lower heigths in rural populations.

Decrease in height and weight as parity grows could be due to the age of the mother, which is usually older in higher parities than in lower ones. It is to be remembered that the weight and size of new-borns increase with parity /Fraccaro 1958, Grande 1974/, but the correlations of these traits in newly-born and adult stages seem to be low /Tanner 1956/. On the other hand, it should be borne in mind that the environment has a great influence on growth during childhood, especially during the first year of life /Hiernaux 1968/, therefore, it would be reasonable to think that intrauterine environment would also be significant in this process.

The ecology of urban populations has determined an important reduction in family size, and so high parities are less and less frequent in today's populations; therefore, the reduction in family size can be considered, jointly with the other ecological factors already mentioned, as responsible for the secular trend in growth.

Urbanization in Spain, with all the ecological consequences here discussed, is a recent event /in 1940, 55.17 % of the population was rural; in 1950, this was reduced to 46.89 %; and in 1970 down to 25.10 %/. So there we may hope that the secular trend in height will continue for several generations more in our country /Bernis 1976/. It is interesting to point out that according to the National Vital Statistics, in 58 years /1900-1958/ height has increased about 2 cm in Spanish young men, and that in only 10 years /1958--1967/ height increased another 2 cm, which shows that this process is spedded up in Spain.

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INTERRELATIONSHIPS BETWEEN SOME SOMATIC CHARACTERISTICS AND HAND STRENGTH OF 14–18 YEARS OLD BOYS AND GIRLS

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ABSTRACT

Coefficients of correlation between strength and stature, body weight and Rohrer's Index were analyzed in 1320 girls and 1820 boys from 14 to 18 years of age. In boys correlation coefficients change regularly with age and are statistically significant in many cases.

INTRODUCTION

In many general-biological papers anatomical, physiological and biological conditionings of muscle strength are dealt with. Also frequently interest was drawn to questions concerning stregth of human muscles. However, the majority of works concerning these questions is limited to the practical aspect and applications of muscle strength measurements in ergonomy, sports or physical education. Most frequently muscle strength of adults is analyzed, there are only few data in the literature concerning changes of physical efficiency during ontogeny /Bogdanowicz 1968, Ilin 1959, Stolz and Stolz - after Tanner 1963, Tanner 1963, Wolański 1957./ Owing to this fact, this paper presents results of analysis concerning changes in interrelations between hand strength and stature, body weight and Rohrer's Index. in boys and girls from 14 to 18 years of age.

MATERIAL AND METHODS

The analyzed data, comparising measurements taken from 1320 girls and 1820 boys between the age of 14 to 18 years, are derived from the material collected in the years 1961-1963 among Pommeranian and Kujawy youths. Strength of hands, being a focus of the analysis, was measured by Collin's dynamometer with accuracy to the nearest kilogramm. Measurements were taken on both hands of an individual, arithmetic mean of the two measurements was taken as actual hand strength of an individual. Furthermore, information on body height and weight was included in the analysis together with Rohrer's Index calculated on the basis of the previous two characteristics. The last data were analyzed previously /Kriesel 1967, 1968a, 1968b/ on a far larger sample.

The analysis was carried out on the material broken down to groups with respect to sex, age and environment. Two environmental categories were distinguished: rural and urban. An individual was included into urban or rural group on grounds of information on his birthplace and place of residence of his parents. Age groups comprise individuals not more than six months younger or five months older than indicated by a value denoting a class.

For all analyzed characters arithmetic means / $\bar{x}$ / and standard deviations / s / were computed. In each group coefficients of correlation between strength and stature, weight and Rohrer's Index were computed. Statistical significance of differences between means was estimated by using Student's t-test, and that of correlation coefficients from table of Wallace and Snedecor /Guilford 1964/.

RESULTS AND DISCUSSION

In analyzing the obtained results we found that urban girls are, in general, in all age groups higher and heavier than rural ones /Table 1/. Rural girls, however, are stronger and more robust as indicated by the higher values of Rohrer's Index. In the same manner differences between arithmetic means for boys are arranged /Table 2/. Hence, differences resulting from operation of rural and urban environment are similar in boys and girls. Taking into account statistical significance of the differences it may be seen that in boys significant differences are more frequent. An overall comparison of mean values, of the characters for boys and girls shows that boys are taller, heavier, stronger and leaner than girls. It is in good agreement with general regularities of sexual dimorphism /Saller - Martin and Saller 1958/.

Table 1. Differences among urban and rural girls in the arithmetical means of the investigated characteristics

Age	Urban				Rural				d	t
	N	$\bar{x}$	$s_{\bar{x}}$	s	N	$\bar{x}$	$s_{\bar{x}}$	s		
Height										
14	94	157.6	.60	5.83	38	155.8	.80	4.95	1.8	.95
15	175	158.4	.42	5.60	169	157.4	.42	5.47	1.0	1.68
16	188	159.8	.41	5.64	200	157.8	.39	5.46	2.0	3.54++
17	106	160.0	.56	5.80	107	158.1	.52	5.36	1.9	2.49+
18	69	159.9	.69	5.70	54	159.3	.71	5.23	.6	.53
Body weight										
14	94	50.2	.75	7.26	38	48.7	1.12	6.92	1.5	1.11
15	175	51.3	.49	6.48	169	50.8	.48	6.21	.5	.73
16	188	52.9	.49	6.71	200	52.0	.45	6.39	.9	1.36
17	106	53.6	.64	6.58	107	53.6	.59	6.13	.0	.00
18	69	54.2	.79	6.57	54	55.3	.79	5.83	.9	.81
Hand strength										
14	94	25.1	.44	4.25	38	27.1	.97	5.99	2.0	1.89
15	175	27.5	.38	5.05	169	27.8	.34	4.48	.3	.59
16	188	27.9	.33	4.46	200	30.3	.32	4.55	2.4	4.31++
17	106	27.7	.41	4.18	107	31.7	.47	4.91	4.0	6.41++
18	69	28.7	.63	5.25	54	31.4	.61	4.48	2.7	3.08++
Rohrer's Index										
14	94	1.27	.014	.14	38	1.29	.026	.16	.02	.68
15	175	1.29	.011	.15	169	1.31	.011	.14	.02	1.28
16	188	1.29	.011	.15	200	1.33	.011	.15	.04	2.56+
17	106	1.31	.013	.14	107	1.36	.013	.13	.05	2.72++
18	69	1.33	.017	.14	54	1.37	.019	.14	.04	1.57

Statistically significant differences at: + $p < .05$

++ $p < .01$

Mean values of three analyzed somatic characters increase with age. Similar regularity, with rare exceptions, can be seen in man values of strength. However, differences of mean values of strength

Table 2. Differences among urban boys and rural boys in the arithmetical means of the investigated characteristics

Age	Urban N	Urban $\bar{x}$	Urban $s_{\bar{x}}$	Urban s	Rural N	Rural $\bar{x}$	Rural $s_{\bar{x}}$	Rural s	d	t
					Height					
14	202	159.6	.60	8.51	98	157.5	.80	7.91	2.1	2.10+
15	254	164.3	.50	7.96	252	161.0	.49	7.82	3.3	4.71++
16	221	169.2	.47	7.01	238	165.6	.48	7.46	3.6	5.36++
17	196	171.7	.44	6.21	160	168.7	.51	6.43	3.0	4.46++
18	129	172.5	.51	5.73	70	170.1	.68	5.66	2.4	2.82++
					Body weight					
14	202	48.9	.62	8.73	98	47.9	.77	7.59	1.0	1.01
15	254	52.6	.52	8.29	252	50.7	.52	8.26	1.9	2.58+
16	221	57.5	.54	8.05	238	55.9	.52	8.03	1.6	2.13+
17	196	60.9	.53	7.48	160	60.0	.60	7.58	.9	1.12
18	129	63.0	.67	7.54	70	62.9	.73	6.07	.1	.10
					Hand strength					
14	202	32.2	.53	7.50	98	33.8	.77	7.55	1.6	1.78
15	254	37.2	.50	7.95	252	38.0	.56	8.84	.8	1.07
16	221	43.7	.61	9.01	238	43.9	.57	8.81	.2	.23
17	196	49.2	.66	9.27	160	49.7	.73	9.21	.5	.51
18	129	48.9	.68	7.76	70	55.3	.88	7.29	6.4	5.76++
					Rohrer Index					
14	202	1.20	.008	.12	98	1.22	.012	.12	.02	1.44
15	254	1.18	.007	.11	252	1.21	.007	.11	.03	3.03++
16	221	1.19	.008	.12	238	1.22	.008	.12	.03	2.65++
17	196	1.21	.008	.12	160	1.26	.010	.13	.05	3.91++
18	129	1.22	.011	.12	70	1.28	.014	.12	.08	6.25++

Statistically significant differences at: + $p < .05$

++ $p < .01$

between subsequent age groups of both urban and rural girls do not show any regularity ascribable to age changes occurring in other characters. In boys differences between mean values of strength for subsequent age classes show more regular pattern of change, comparable to tha occurring during growth of other characters in the investigated period of ontogeny. Firstly, the differences increase, reaching maximum between 15 and 16 years, then slowly diminish. This is illustrated by the tabulation of differences between arithmetic means of the age groups:

age	urban boys	rural boys
14-15	5.0	4.2
15-16	6.5	5.9
16-17	5.5	5.8
17-18	-0.3	5.6

Taking into account that velocity peak of body height growth found in longitudinal studies of the same boys /Kriesel 1967/ occurs between 14 and 15 years of age it may be suggested that the velocity peak of strength occurs at least one year later, Since the data concerning hand strength are cross-sectional it is impossible to establish accurately the moment of adolescent growth spurt for strength, but what is found in the present work agrees sufficiently well with data of Stolz and Stolz /Tanner 1963/.

Insignificant differences between mean values of strength for girls of various ages support rather obviously that adolescent growth spurt of strength in girls occurs earlier than in boys, hence our data concern further, less intensive stage of growth.

All correlation coefficients in boys are positive, their values change with age rather regularly /Table 3/. In age 14 and 15 years in both urban and rural boys correlation coefficients for interrelation between stature and strength have the same value indicating high interrelation of the analyzed characters. In the next age groups correlation coefficients systematically decrease. Only in the group of 18 years old urban boys the value of the coefficient is higher than in the preceding age group. Assuming that this is a random event we may take the decrease of correlation between stature and strength with age as an indicator that strength is more dependent on developmental age than on stature. For only in those age groups in which developmental age is strongly related with body height significant correlations between strength and stature exists.

Table 3. Correlation coefficients between hand strength and other characteristics

age	height	body weight	Rohrer's I.	height	body weight	Rohrer's I.
		Urban girls			Rural girls	
14	.19	.39	.28	.31	.44	.36
15	.32	.33	.12	.16	.23	.09
16	.44	.36	-.04	.22	.29	.15
17	.27	.38	.18	.19	.33	.26
18	.06	.16	.10	.14	.20	.08
		Urban boys			Rural boys	
14	.67	.63	.07	.67	.69	.11
15	.67	.66	.24	.67	.73	.27
16	.50	.62	.32	.59	.67	.22
17	.25	.51	.39	.37	.58	.33
18	.44	.52	.18	.11	.58	.42

Relations between hand strength and body weight of boys are relatively high in separate age groups. In analyzing the values of correlation coefficients in successive age groups it may be seen that at the beginning the values increase, reaching maximum in 15 years old boys, afterwards they slightly decrease year by year. Since values of coefficients are statistically significant even in the oldest age groups it may be concluded that interrelation between the characters will be persistent in further life independent of age. This conclusion is supported by the obvious consideration that strength of muscles depends on their mass, this in turn has a considerable share in general mass of the body. In the same vein correlation coefficients for relation of strength to Rohrer's Index may be interpreted, despite that they do not reach values enabling unequivocal conclusions to be drawn on interrelation of the analyzed characters. But because values of these coefficients increase with age, what is more keenly expressed in rural boys, it may be concluded that increasing with age ratio of body weight to its height is mainly due to the enlargement of the mass of muscles.

Coefficients of correlation between strength and other characters in girls do not show changes with age as regular as in boys /Table 3/, hence the results for girls are more difficult for unequivocal interpretation. It seems that the reason for obtaining such results is known. For during examination it has been observed that girls are far less interested on obtaining high results on the dynamometer than boys. Accordingly we may suspect that results obtained by girls were not always adequate to their actual physical capacity. That is why in many instances correlation coefficients in girls are statistically insignificant and the eventual conclusions are unreliable.

The above analysis allows to state that strength of muscles flexing the hand increases with age. It is more evident in boys than in girls and stronger in rural than in urban youth, despite that a rural youth is on the average lower and lighter. Rural living conditions result in very early burdening of children with physical labour that is a sort of training enabling more intensive increase of strength and giving higher muscle strength attained during development. It is highly probable, that more intensive growth of strength in rural children impedes growth and development of their organisms.

In the investigated period of life there no significant correlations were found between hand strength and stature, weight and Rohrer's Index of girls. This fact can be explained by the obvious unwillingness of girls to perform strength measurements.

Coefficients of correlation between hand strength and the three analyzed somatic characters in boys change regularly with age being significantly high in many instances.

Changing with age values of correlation coefficients suggest that hand strength of the examined boys depends on their developmental age and the share of muscle weight in the total body weight.

No differences in values of correlation coefficients are found between urban and rural youths.

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BODY HEIGHT AND RELATIONS OF MEASURED LENGTHS

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ABSTRACT

Consisering the methods of Breitinger in determining the body height, to be reconstructed from the length of the long bones in man, I tried to show in detail that in every critical examination of measurement relations only the momentary situations of growth process are expressed. The stages of growth, presented by specific growth processes, depend on the development of all organs /allometric problem/.

From the "Längsschnitt" study on school children in Braunschweig we also try to give record on some growth gradients with correct mathematical methods, to show the individual stage of developmental age from a morphological aspect with a view to the stage of mental maturity.

Our study on growth and maturity processes resulted in the cognition of the final body proportion in adult individuals.

Growth and the reached stage of maturity exert influence on body proportions. But they are not necessarily strictly related. Perhaps there is an independent control of growth and maturity in the phenotype as well as in the genetical basis.

CONTRIBUTION TO THE PROBLEM OF INDICES, ALSO IN RESPECT OF THEIR DEVELOPMENTARY ASSERTING IMPORTANCE

Descriptive and comparative morphology are still the main problem in anthropological science and serve in many ways the separation of taxonomic and typological units. Many body characteristics can be recorded and in this way various individuals can be compared by means of their measurements. It stands to reason that a simple, direct comparison of some measured lengths in itself does not tell much, because its dependence on body height is evident. For quits some time certain authors have been working on an additional examination of body proportioning. They tried to express the individual stages by means of indices. The measured length x is expressed by the percentage of another length y. As far as this index is only used for a descriptive analysis, we make no objection to its application. Problems are arising when further details are to be received from this kind of recording body proportions.

In this case we must think of all factors which exert influence on body proportions, like body height /May, Speitling 1975/, also specific genetic aspects, which have to be taken into account, if they cannot be eliminated.

An adequate method is allometric operation. First of all it must be mentioned that "body heights correlated changes" of many indices /when following allometric rules/ are received by different methods. Vogel /1965/ with reference to Röhrs /1961/ gave a good survey on the different forms of "allometry" in anthropology: 1. ontogenetic, 2. intraspecific, 3. interspecific, and 4. evolutionary /phylogenetic/ type of allometry. Vogel /1965/, unlike Rensch /1972/ and Hemmer /1967/, pointed out that in most cases ontogenetic allometry does not agree with intraspecific allometry, being again different from interspecific allometry. Therefore, one cannot see general evolutionary factors while evaluating allometric constants. This opinion, I believe, has been established only by empiric examination. The true coherence, as far as I know, was never proved sufficiently in theory. Obviously, this is the main problem arising from every longitudinal study, where varying classifications of growth processes are to be examined.

I would like to introduce some of my ideas, but first I wish to give my opinion on the allometric term. Some technical dictionaries are defining allometry as "a different growth velocity of body organs". It has to be emphasized that the true growth velocity of any measured body length, can only be determined by an ontogenetic allometry /like longitudinal study/. I tried to prove /May 1975, 1976/ that the allometric relation should be a suitable parameter for the dimension of body /body height in man/, because the metric development of organs can only be evaluated considering the total body growth /keeping the allometric relation in mind/. This idea would do justice to the definition of allometry given by Rensch /1972/, but unfortunately, is not taken into consideration by most of the authors /Hemmer, Frick, Röhrs and others/. Usually, we find many authors talking already about allometry, when they put their divariate measurements in a logarithmical regression computation and express it by means of the Snell-formula $y = b \cdot x^a$. It makes no difference which pair of body marks is examined and it is also independent from whether the data derive from an ontogenetic series or not.

Figures 1 and 2 demonstrate a constructed scheme and lucidly explain the theoretic of relations of ontogenetic and intraspecific allometry, respectively isometry, for every chronological age. In Fig. 1 individual specific growth gradients, but for the observed length of time constant growth gradients, were assumed. Age concerned intraspecific allometry, respectively isometry, is regulated by two, possibly more or less independent, variables: the first one, - the relation of the corresponding individual growth velocities - causes the population specific deviation of the increase of the ontogenetic mean allometry line. The second, which is the absolute growth velocity, varies also individually and decides how far an individual gets to on his special /ontogenetic/ allometry line /b/ as to the point of time T_i. By this example we can understand that constants of corresponding ontogenetic and intraspecific allometry could agree only in a very few exceptional cases. There are no reasons for the assumption that these special cases are the rule. Fig. 1 also shows that the intraspecific /"A-"/ regressions /under the conditions of this scheme/ from purely mathematical reasoning do not differ in the allometric constant "a", if their increase /"a"!/ is not corresponding with the ontogenetic allometry /growth-!/ line. The A-Regressions referred to the allometric formula, are different in factors b. That means in general we can count on a shifting of the intraspecific allometry line in the direction of the ordinate, while growth is proceeding. A similar fact could be expected for the intraspecific comparison of populations whose sizes differ in average or so to say populations which are more or less accelerated. Later on I want to talk about acceleration under these aspects more in detail.

The theoretical contest I have described so far, shall be briefly illustrated in Figs 3 and 4: Here an older correlation table /Bach 1926/ of body heights and body weights was drawn allometrically for boys up to the 17th year of their life. Regarding the intraspecific regression lines to the chronological age averages up to the first year, a parallel shift in the direction of the ordinate /see above/ is evident. For this age interval the ratio of growth gradients of the inquired measurements is fairla the same. This is changing significantly between the first and second year in a way that the intraspecific regression lines later on do not differ much or not at all. Disregarding the statistical error probability we find that especially the "A"-regression lines of the 4th - 5th year, and also the 5th - 6th year agree, but even more the "A"-regression lines also agree with the ontogenetic mean allometry line. This, I do believe, is not a matter of coincidence. For a theoretical discussion of such a situation I have constructed Fig. 2. In this scheme /double logarithmic graph/ different chronological stages of age were changed repeatedly in ratio of growth gradients and so the modification of direction of the ontogenetic allometry line was supposed and drawn in.

The condition for this scheme is also the simplification of the assumption that the ratio of relative growth velocities is constant for all individuals during the length of time which has been observed. Under these circumstances the spread of the series of points /relation of measurements of the individuals/ and by this the direction of the "A"-regression lines cannot change, not even if the ratio of growth gradients /which is expressed in the progress of the ontogenetic allometry line/ is changed. Differences or conformities of the "A"-regressions referring to age, in the allometries /"B"-regressions/, which are within a definite time extended directly in front, depend, under the conditions given in Fig. 2, primarily on the actual ratio of the compared growth gradients. In the diagram they are determined by the increase of the "B"-regression line. By this we can see that conformity in ontogenetic and intraspecific "allometry" ordinarily does not seem to be based on relations in causality. Even more we can expect all kinds of allometric formulas /as seen above/ more or less to be ordinarily only significant for a limited range of body height and age. First of all the growth gradients are practically never continuously constant, while ontogenetic growth is proceeding. Secondly, with increasing the final body height means there will also be a parallel shift of the intraspecific allometry line in the direction of the abscissa, in case that the increase of the intraspecific allometry line is more flat than the increase of the ontogenetic allometry line directly extended in front.

To avoid misinterpretation in a survey on body proportioning one has to consider the points of view that were mentioned, as well as supplementary biological criteria, which also concern the basis of the investigated material. I will only mention the need of a population specific definition for the groups which are to be compared, with their typological and regional differences. I want to give importance to the possibility of recognizing the acceleration which may occur. We define acceleration as an average increase of the body height in a certain length of time. It may be influenced by allometry or even more it might be coupled to other processes in the shift of proportion and stages of development, for instance by hormones. In our longitudinal study it is a main point to investigate the "rate of acceleration" because of its importance to sport specific and typological problems. Finally, we will evaluate the resulting ultimate "stadial" body proportions in this context to avoid misinterpretation with regard to the aspect.

Whether a certain examined group is accelerated or not, whether for instance a tall mean body height is a population or taxonomic specific character, or even a "racial" mark, can under certain conditions, in my opinion be proved by allometric diagrams. To be sure this is true, one must know the ontogenetic and intraspecific allometry line, so that first of all from these results an "acceleration-trend-line" for a comparable population is drawn. A relevant statistical deviation of a sample could then, under certain conditions, give evidence of a typological difference. In Fig. 5 I tried to show such an event. Looking at the graph one will find that there is no general "acceleration-trend-line" for all age groups, because of the "stadial specific" growth gradients. Therefore, it is necessary to figure out different "acceleration-trends" for either the adults or certain chronological age groups. Discrepancies in regard to biological age, which find expression in a shift of measurements, will enter the statistical varience. The right section of Fig. 5 is a part from the total survey. The left section shows the total survey by means of change in the ratio of two measurements achieved from the growth up to the 17th year. Two surveys from the central European region, from Belgium /Quetelet/ 1835 and Switzerland /Geigy/ 1956 have been compared. We think that the genetical differences between these two populations are not very important for our questioning /Fig. 6/. Acceleration can be found in the distance of both curves, but also in the distance of the points /means of the sample/ which are substituted to the chronological ages. These values, which give view on 120 years of acceleration in Central Europe, permit us to estimate by means of interpolation an acceleration-trend-line for the mean chronological age /6.48 years/ of our sample. Extrapolation of the trend-line provides a prospective value for our sample.

In comparison to this prospective values the actual value deriving from our sample is a little too low. Nevertheless, it is definitely higher than the interpolated value for 1956. From our estimation we can still observe a further continuation of acceleration /by means of the definition given above/. A slow-down cannot yet be proved in our longitudinal study.

In my graphs and explanations I try to show that the phenomenon of acceleration cannot be understood sufficiently without regard to body proportioning. As in relation body height/weight we also put some other important body measurements in relation to body height and in this way we receive the mosaic of regular changes of body proportioning. We believe that discrepancies from acceleration-trend-lines which may be typical for populations can be determined by statistical methods. In my opinion the knowledge of the development of only one measured length, even if it is the body height itself, does not allow statements in respect of acceleration.

Finally, I would like to make a short remark on the problem whether any "stadial" shifts in the stages of development may occur in the accelerated one. Dimensions which are also influenced by hormones are considered to effect these shifts. For the relation of body height/weight of boys up to the 17th year of age this effect does not occur. I gave a proof in comparing the sum-percentage, distribution and found absolutely equal curves /Fig. 6/. But, of course, this could be different for any other pair of measured lengths.

*

ACKNOWLEDGMENTS

I must finally pay tribute to the friendly promotion and co-operation, with which Prof. Kurth has eased my studies in the longitudinal study of Braunschweig.

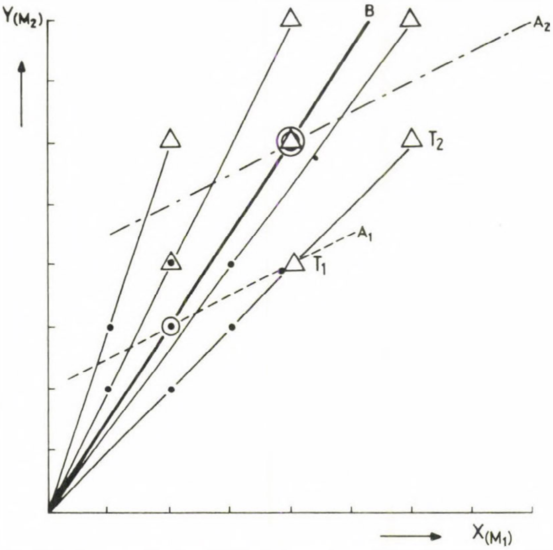


Fig. 1: Schematic model /arithmetic graph/ of the variation of two measured lengths /M_1 and M_2/ while growth is proceeding /Further explanation in the text/

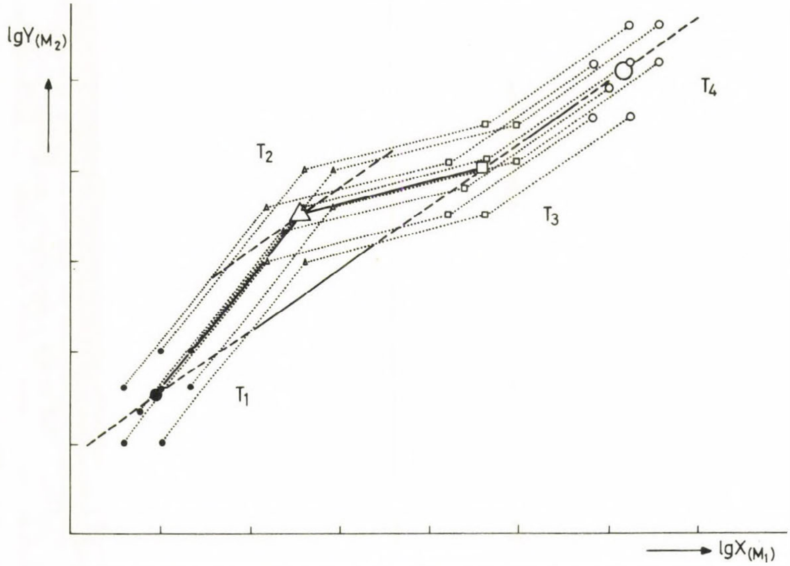
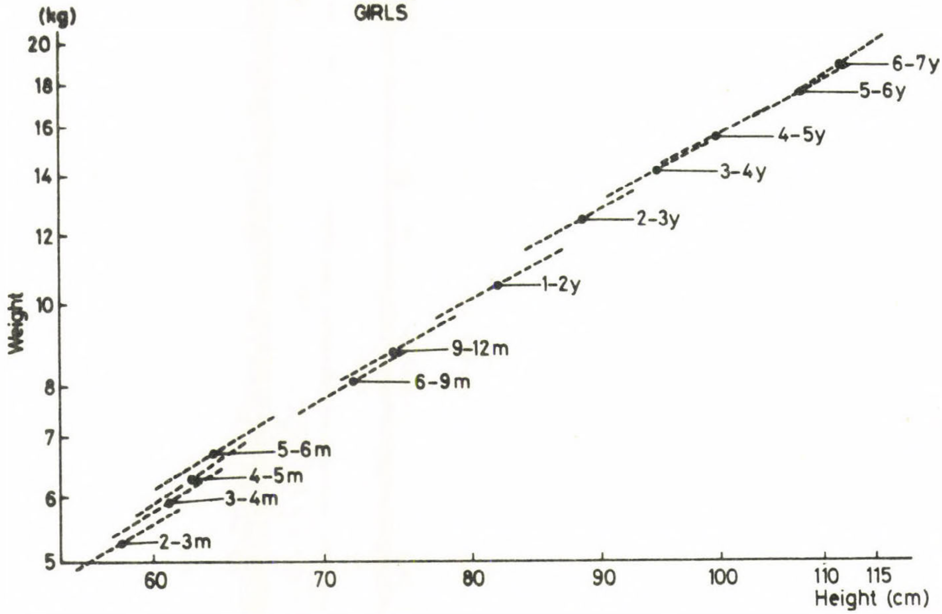
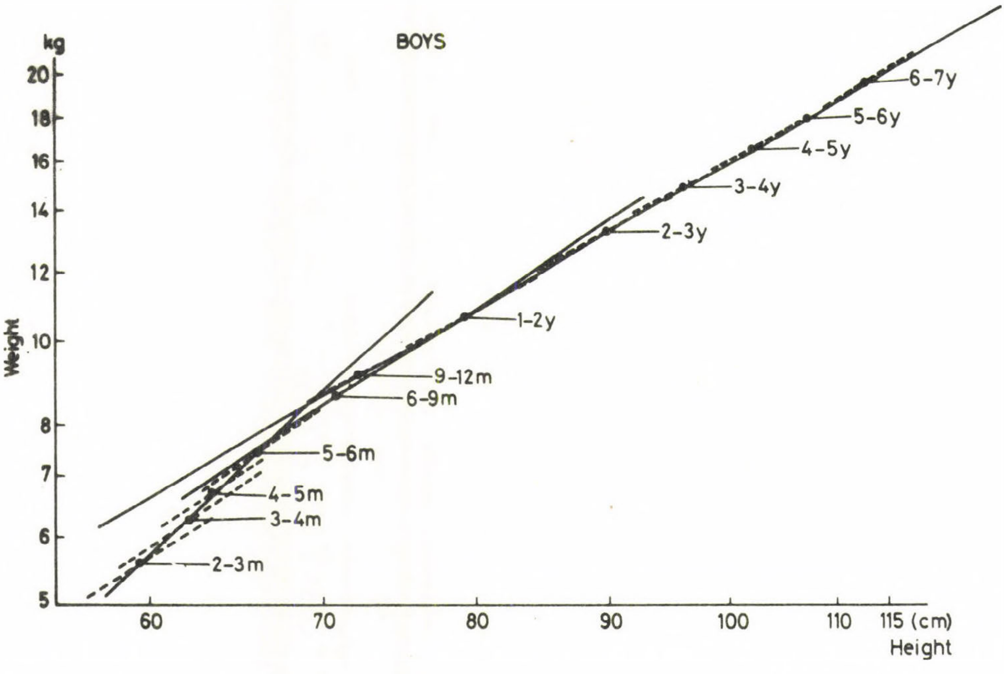


Fig. 2: Simplified schematic model /double-logarithmic graph/ of the variation of two measured lengths within a population, while growth is proceeding. Only the dark unbroken and the dotted lines demonstrate real allometry /Further explanation in the text/

• △ □ ○	Individual values	to the point of time $T_1 \ldots . T_4$
● △ □ ○	Means of the sample	





Figs 3-4: Relation of body height and body weight of children /3. for girls; 4. for boys/ at the age of 2-3 months to 6-7 years /from a correlation table in Martin, 1928. Further explanation in the text/

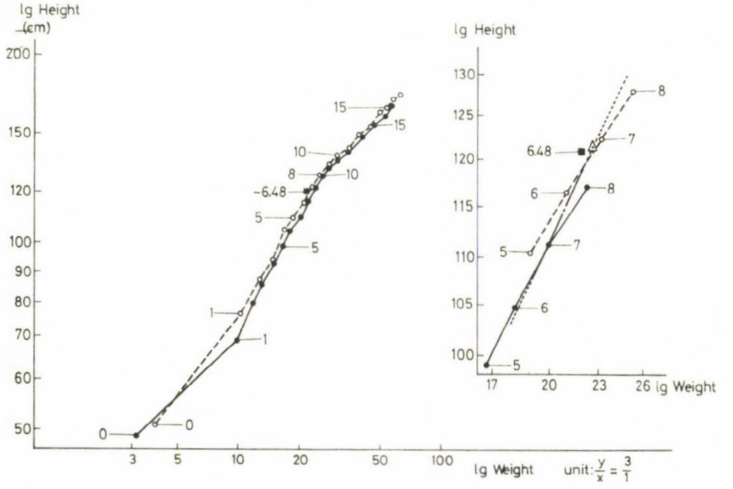


Fig. 5: Double-logarithmic graph shows the correlation of body height and body weight from growth of boys up to the 17th year of age. The data derives from different European populations.

Longitudinal study from Belgiam cross-section /Quetelet 1835 in Martin 1928/. No further information available.

Longitudinal study from a cross-section in Switzerland /City of Basel/ in the years 1956-57 /From Documenta Geigy, 1975 N = 2150/

Estimation on the process of acceleration following the hypothesis of biological comparability and statistical relevance.

△ Today's prospective value for the chronological age of 6.48 years.

■ Actual value for the chronological age of 6.48 years /Brunswik, section 1974 N = 176/

The numbers, substituted for the points of the curves, show the corresponding chronological age of the examined groups. The distance between the points of the same age groups and of the two curves in total demonstrate "the stage of acceleration".

The right side of the diagram is an enlarged cutout from the left side. From this graph the Brunswik material would appear a little less accelerated than expected, by means of the extrapolated prospective value, in case the published results are representative for the corresponding population.

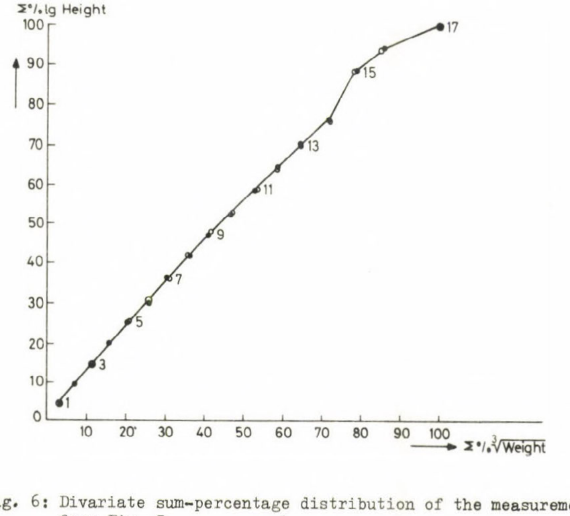


Fig. 6: Divariate sum-percentage distribution of the measurements from Fig. 5.

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SENSORYMOTOR DEVELOPMENT IN PAPUAN INFANTS

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Reports from African countries and the U.S.A. deal with problem of precocious motor development of negro children. /Geber 1953; Scott et al. 1955; Griffiths 1969/ It is, however, not entirely settled wether the observed fast development rate is congenital or acquired by special conditions, such as carrying, nursing and close mother-child relationship /Geber et al. 1964; Parkin 1971; Geber 1957/. The reported fast development rate in African children stops at the second year, but subtle differences in motor skill may continue beyond this time. Assessments of neonates, infants and children were carried out in Papua, New Guinea, to compare somatomotor differencies in various ages to Europeans.

The observations were made in the Morobe district in coastal and highland villages. Neonates were studied at Angau Memorial Hospital, Lae, infants and children in the villages around the Snake river. Altogether 12 normal neonates, 5 premature babies, 48 normal infants, 46 children, one hydrocephalic newborn, and one newborn baby with an occipital meningocele were studied.

Methods:

In neonates and infants the following functions were studied:

Visual function

Reaction to light. Pupillary reflex.

Fixation.

Object following /vestibulo-ocular reflex/

III. IV. VI. cranial nerves.

Oculopalpebral reflex.
Doll's eye.
Turning towards light.
Returning of presented smile.
Visuo-motor coordination.
Visual orientation.

Hearing

Cochleopalpebral reflex.
Orientation /startling/ to auditory stimulation.
Habituation to auditory stimulation.
Dyshabituation to auditory stimulation.
Motor inhibition to auditory stimulation.
Arousal reaction to auditory stimulation.
Ventillatory reaction to auditory stimulation.
Sound discrimination.
Turning towards sound.

Tactile sense

Asthesia.
Algesia.
Discrimination.

Consciousnes, attention, elementary memory, accomodation, rhytmicity

Activity rate.
Attention, stimulus-time relation.
Dynamics of behaviour.
Consciousnes.
Defective consciousnes, deprivation.
Disturbed consciousnes /telencephalic, diencephalic, brain stem type/
Alert and sleep periods, rhytmicity.
Quantity of sleep.
Quantity of alertnes

Locomotion. Motor control in evoked postural reactions

Symmetric tonic neck reflex.
Asymmetric tonic neck reflex.
Head elevation in prone position.
Head and trunk position in steep prone position.
Chain reactions in prone sway.

Chain reactions in supine sway.
Rotation by shifting the leg.
Change of the prone sway to lateral sway.
Inhibition of rotation.
Placing in vertical position.
Support in vertical position.
Primary walking.
Primary walking /upper extremities/.
Sitting when lifted from supine position.
Sitting while shifted from supine position with fixed legs.
Spontaneous rotation.
Crawling provoked by elevation of the head.
Crawling provoked by elevation of the chest and head.
Straightening reaction of the trunk in vertical sway.
Spontaneous crawling, rocking.
Reaching and grasping to lift the body in vertical position.
Stance with grasp.
Stance without grasping.
Walk, step.
Standing up.

<u>Motor control in complex movements</u>

Defensive flexion in the upper extremity.
Defensive flexion in the lower extremity.
Crossed extensor reflex in the lower extremity.
Rotation of the trunk.
Moro reaction.
Startling reaction.
Balance reaction with the upper extremity.

<u>Motor and sensory control of arm and hand movements</u>

Elementary grasp.
Forced grasp.
Plantar grasp.
Outreaching.
Outreaching to visual stimulus.
Contact with objects.
Elementary forced grasp.

Manipulative movements.
Precision grasp.
Explorative movements.

Vocalisation and speech

Crying.
Sound production.
Bla-bla.
Words /vocabulary/.
Association of word-meaning.
Active connection of words.
Speech.
Defect in vocalisation.

Mental faculties

Infant-mother connection.
Psychoaffectivity.
Orientation.
Adaptation to tasks.
Elementary learning.
Concentration.
Will.

Results:

Special attention was given to the eventual precocity in somatomotor development, sensory function and reactions to external stimuli in Papuan neonates and infants up to lo days, but no difference was found compared to Europeans.

Attention was given to the possible influence of the fact that Papuan babies were carried very often, but again no sign of earlier development of attention, reaching out to objects, interest in the environmental events, or earlier motor development was observed.

There was no sign of any influence of this extensive carrying habit on the behavioural development of the infants.

Local habits and social conditions seem to play an important role in conditioning and influencing the behaviour and physical abilities of Papuan children. In contrast to this, congenital capabilities, and carrying, as well as nursing, exert no influence on nor activate precocious motor development.

Social habit and way of life trains the children to a very early and precocious development, but in the sense of social responsibility and reliability, not in sensory experience, integration or somatomotor development.

Summary:

Normal term babies, premature babies and normal children in various age groups were studied with regard to sensorymotor development in Papua, New Guinea. No congenital or later acquired precocity in somatomotor development in either age group was observed. Carrying and nursing of babies extensivly practised in the highland and coastal villages did not seem to affect development. All reactions and performances of Papuan infants were similar to those in Europeans.

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MORPHOMETRIC CHANGES IN SARDINIANS OF DIFFERENT AGES

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ABSTRACT

Morphometric characteristics in a group of varied subjects, children of both sexes, adults, and individuals in the senile and presenile age groups, were studied. For outlining the changes occurring in the evolutive and involutive growth stages we resort to the anthropometrographic method, which gives us a cocise view of auxological phenomena and some appropriate body indexes. In the senile involution the abdomen is seen. A general diminution in height is also evident. These facts, when compared to those of the other adult subjects, lead us to a brachytypia diagnosis.

Finally, we studied the physical changes occurring in Sardinians over a length of time, whilst taking into account senile involution and the secular tendency towards an increase in height owing to recent changes in environmental conditions of the island.

INTRODUCTION

The relative results of a constitutional survey on morphometric changes which occur during the different growth stages are presented, dealing in particular with the adult, presenile and senile phases.

The survey was carried out with the aid of Brian's anthropometrographic method /Brian 1970, Brian et al. 1968, Floris 1974, Maxia et al. 1976/ allowing a quick construction of individual graphs /anthropometrograms/, which in turn permit an immediate view of relations between the different parts of the body and partial diagnosis and trends of the constitutional types. For the pre-adult stage we used Rohrer's index which relates the body weight to the cubic stature so taking into account alternations between turgor and proceritas phases which occur in this growth stage. The study of the presenile and senile morphometric aspects was carried out with the collaboration of the I.N.R.C.A. /National Institute of Rest and Cure for the Old/ with the intention of adopting an individual constitution card together with the normal clinical one.

MATERIAL AND METHODS

We present the figures concerning 235 adult Sardinian males betweer the age of 25 and 50 years /average 39 years 7 months/ and 100 adult females between 21 and 40 years of age.

Their average figures allow the construction of a general graph /standard form/ in which are also included the figures relating to 130 males between 51 and 65 years /average 58 years 1 month/, in the decreasing virility period /Castaldi 1928/ and those relating to 52 males between 66 and 83 years /average 77 years 1 month/, in the old age group.

As for the females, we also included in the general graph figures relating to 100 women from 41 to 55 years old and to 100 from 56 years onwards.

As far as growth in the pre-adult period is concerned we considered the figures relating to 472 individuals from 6 to 24 years old.

Apart from the weifht the following eight classical anthropometrographic measurements were considered: standing height /1/; sitting height /2/; lower extremity length /3/; antero-posterior diameter of the thorax, for the xiphoid point /4/; biacromial breath /5/; pelvic breadth /6/; xiphoid chest girth /7/; waist girth /8/.

The comparisons for the partial diagnosis are made between the following pairs of figures /the first indicates longilinia, the second brevilinia/: 1-2, 3-4, 5-6, 7-8. 2-7, 1-8.

RESULTS

a/ MALE ANTHROPOMETROGRAMS

In Fig. 1 the relative figures for the groups of individuals between the ages of 51 and 65, and 66 and 83 years old are inserted in

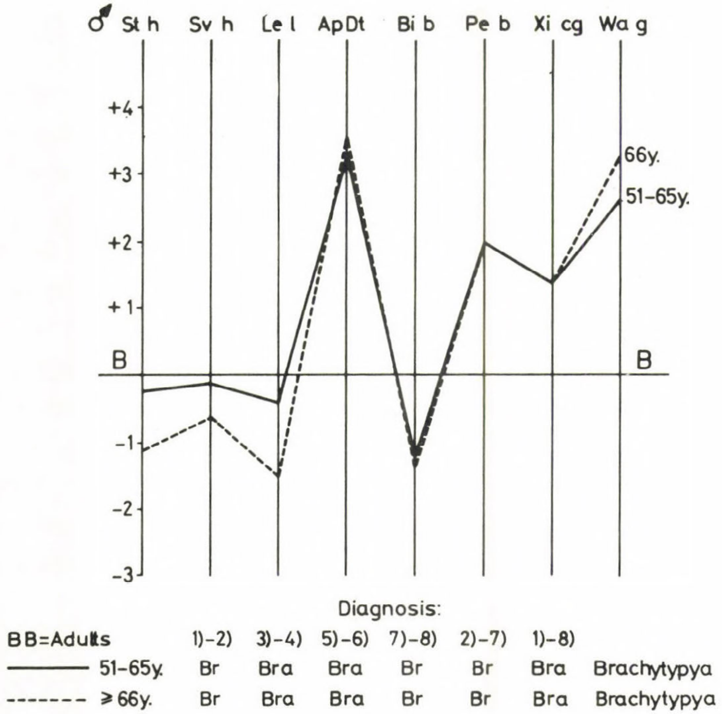


Figure 1 - General graph concerning 235 adult males

the general graph concerning the average figures for 235 adult males. In both cases a diagnosis tending to brachytipia was obtained. It was noted that there is a lengthening of the sitting height when taken against the standing height. This is more clearly seen in the senile age group, sign of a shortening of the stature with age. There is also an increase in the size of the pelvis with a simultaneous decrease in the shoulder size, giving us a ginomorphic type constitution /Ciuca 1974/. There is a transversal reduction in the diameter of the thorax and an increase in the antero-posterior diameter of it /Castaldi 1928/ and also an increase in the two perimeters /thoracic and abdominal/ attributable to a rise in the amount of adipose tissue in the corresponding parts and a falling of the viscera in older people.

When considered together, the individuals in the senile rather than those in the presenile group show strong characteristics caused by ageing, excepting the two transversal diameters, which show more or less the same figures.

Included in Fig. 2, still on the general graph relating to adult males, are the relative average figures from a group of individuals /No.34/ between the age of 18 to 25 years /postpuberal period/. In this case the diagnosis is of longitipia, though the younger group presents smaller figures than the adult group. Here a lengthening of the leg and of the standing height and an antero-posterior flattening of the thorax are to be noted. The two perimeters, particularly the abdominal one, are much smaller than those of the average adult, whereas the biacromial size, which, we must remember, can continue growing until the age of 30, is nearly the same as in the adults /Olivier 1960/.

b/ ROHRER'S INDEX IN THE MALES

Rohrer's index of the different growth stages, from turgor secundus /6-10 years/ to senility /above 65 years/ is shown in Fig. 3. The index is high during the turgor phase then lowers during the successive prepuberal proceritas phase, after which it rises continually, less strongly in the puberal and postpuberal periods, but more noticeably in the successive growth periods. It then remains on the same figures during the presenile and senile phases.

Figure 2 - General graph concerning 235 adult males

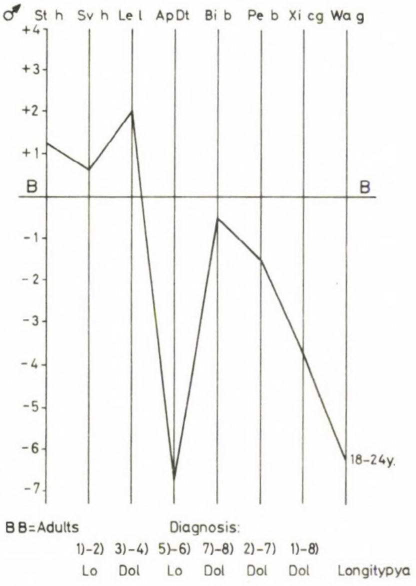
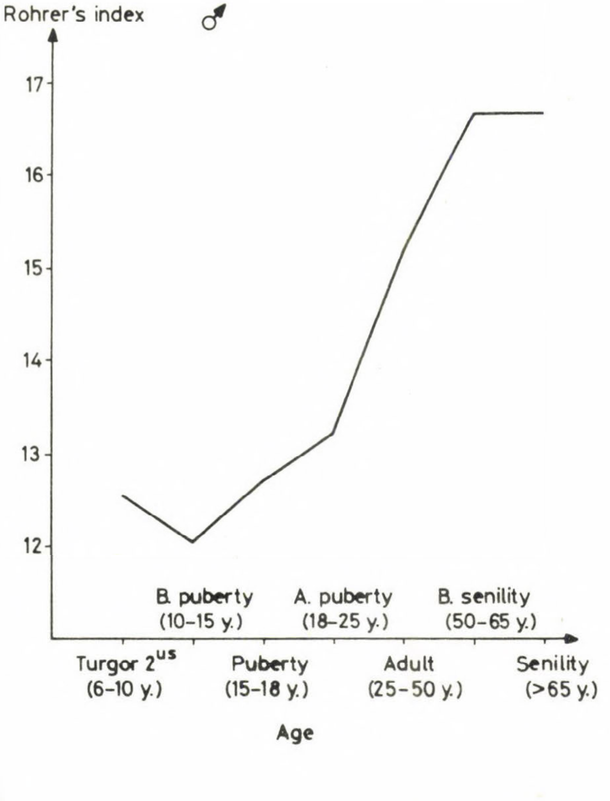


Figure 3 - Rohrer's index of the different growth stages



c/ ANTHROPOMETROGRAMS IN FEMALES

In Fig. 4, in the general graph concerning the average figures for 100 women between 21 and 40 years old, are included the data of 100 females between 41 and 55 years and 100 from 56 years old and above. As is the case with the males both diagnoses are of brachytipia with an emphasis on a shortening of the stature and with a lessening of the biacromial diameter: basomorph in women over 56 years old. Similarly to males the thoracic and above all the abdominal perimeters are noticeably larger, a sign of a rise in adipose tissue content in the trunk /Cristescu et al. 1975/.

d/ SOME CONSIDERATIONS RELATING TO GROWTH

The stature grows with time /secular evolution/. This is due to many factors, among which we cannot ignore /even if these are held by some to be not very important/ better living conditions /economical, hygienic, sanitary, food, etc./. We have in Sardinia the conscription details for the years 1879-'83 /Livi 1896/, 1950-'51-'52 /Marotta 1954/ and 1972 /Cappieri 1975/ which give respective heights, with corrections by Cappieri /1960-'61/ of 161.7, 163.6 and 166.2 cm. Therefore, in a period of approximately 9.1 decades there was a complete growth of 4.5 cm. There was not a regular rise during each decade but the three figures give us an average growth of 0.62 cm in each decade. At the same time, we know that, because of anatomical changes, particularly to the spinal column due to senile involution the height decreases with age, beginning at about 45 years old.

Table 1 - Mean values of Sardinians

Body measurements	18-24 y	25-50 y	51-65 y	66-83 y	21-40 y /females/
Standing height	168.63	164.52	163.72	161.19	154.62
Sitting height	86.18	85.20	85.01	84.27	80.50
Lower extremity length	82.43	79.32	78.71	76.92	74.11
Antero-posterior diameter of thorax	18.51	21.44	22.89	22.97	17.P9
Biacromial breadth	38.58	38.91	38.04	37.81	34.69
Pelvic breadth	28.08	28.92	30.04	30.01	28.46
Xiphoid chest girth	82.97	89.57	92.03	92.01	72.55
Waist girth	73.26	83.64	88.06	89.14	67.11
Standard deviation of the standing height	5.83	5.47	-	-	5.34

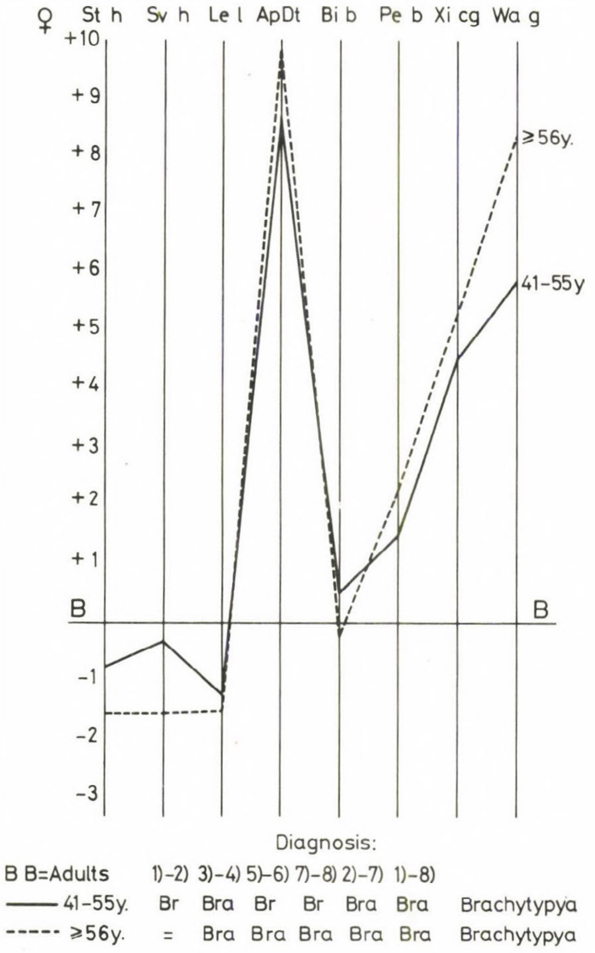


Figure 4 - General graph concerning 100 adult females

In our specimens there was a difference of 3.33 cm between the average height of the adults /164.52 cm/ and that of the senile individuals /161.19 cm/ with an average age difference of 3.16 decades between the two groups. Applying the growth per decade /0.62/ to this height difference of 3.33 we see that 2.02 cm /61%/ is due to secular evolution and 1.31 cm /39%/ to senile involution. These figures are almost the same /60% and 40%/ as those obtained in France /Susanne 1974/ and may therefore reflect a general biological phenomenon.

In conclusion we can say that the height of Sardinians is still increasing, though the genetic potentialities of the Sardinian population are not completely shown, as appears to be the case for example in the United States.

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SOME PROBLEMS CONCERNING THE GROWTH OF TRIPLETS IN BULGARIA

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ABSTRACT

The author reports on some demographic data concerning the triplets births during the last 10 years. Twelve, from all triplets born in this period, were studied both longitudinally and transversally. The diagnosis of zygoty was made after the method of similarity.

Data about physical growth, the puberty and the sexual differentiation of the triplets children in different periods of their growth process were analyzed. The author gives also a comparison with some indices of the physical growth of twins and non-twins children of the same age.

INTRODUCTION

The study of the complex mechanism of the physical development of children has good traditions in Bulgaria. We can list not only some research workers dealing in these investigations but whole, teams too creating schools on these lines. Kadanov and coworkers from Sofia, Stanishev and coworkers from Plovdiv, Yanev and coworkers from Sofia are among the most distinguished ones in this field of research.

For ten years our laboratory has been studying twins one of the aspects of this long and many-sided process, called "physical development", and its dependence on heredity. Our investigations covered groups of children being twins studied both transversally and longitudinally. Our results from these investigations suggested to us to check up some of them on a "combined model" too, i.e. on triplets and quadruplets.

The present work is only a part of our investigations on triplets and quadruplets in Bulgaria to form a separate chapter of a monograph about multiparity in Bulgaria. We shall dwell upon some data about the physical development of children being triplets and a genealogical analysis of some of them.

MATERIAL AND METHOD

Actually all multiparity births having occurred in Bulgaria during the past ten years were analyzed demographically in our laboratory not only generally for our country, but in detail too, by the separate regions where we study the anthropological status of the contemporary population in Bulgaria. Due to the great rarity of higher multiple births and on account of the fact that tehy are scattered all over the country, in this first report we shall analyze only 12 triplets and one quadruplets, all children being alive and well at present during the last examination. In our paper we have used the works on frequency of higher multiple births, their distribution in the different countries and races, dependence on maternal age and parity by Allen, Allen and Firschein, Bulmer, Jenkins and Gwin as well as the only monograph about triplets by Degenhardt including 22 triplets from all the regions of the German Federal Republic, investigated by all these indices together with data about the mother's gestation, birth and initial periods of the physical development.

The material we studied originates from different regions of Bulgaria /Sofia, North-East Bulgaria and South Bulgaria/. The investigated children are of different ages ranging from 3 to 10 years of age. The quadruplets are 15 years old. We dispose of data about the over-all dimensions of each triplets at least for four periods: birth, 1 year of age, 2 years, of age and the moment of the last examination during the current year. From the last examination we have 31 anthropometric features year. For each group of children we have studied also the terms of their psychomotor development, gradient of the inteligence, as well as infectious and non-infectious morbidity.

RESULTS AND DISCUSSION

By the method of similarity /using serologic, scopic, metric features and data about the fetal membranes/ we have determined the triplets' zygosity. Out of the 12 triplets 9 are like-sexed /5 triplets

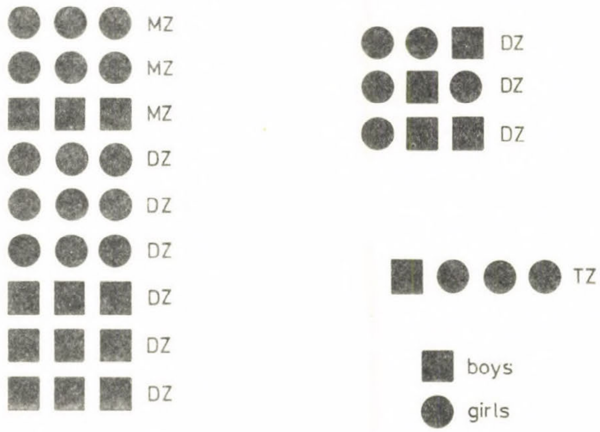
MZ
MZ
MZ
DZ
DZ
DZ
DZ
DZ
DZ
DZ
DZ
DZ
TZ
boys
girls

Fig. 1.

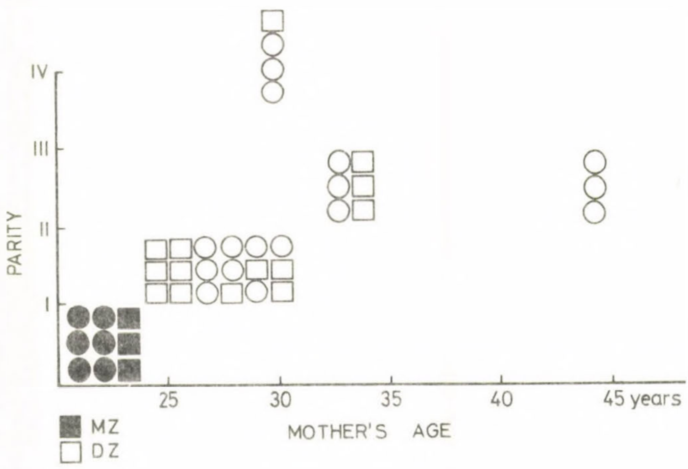
IV
III
II
I
PARITY
25
30
35
40
45 years
MOTHER'S AGE
MZ
DZ

Fig. 2.

have 3 girls each and 4 have 3 boys each/. Out of the nine like-sexed triplets 3 are monozygotic and the remaining ones are dizygotic. There are no trizygotic triplets in the material analyzed. The quadruplets are trizygotic /Fig. 1/.

The three monozygotic triplets were born at the first gestation of the mother under 25. All the ramaining ones were born at the second and third gestations. The quadruplets were born at the fourth gestation of the mother over 25. The one dizygotic tirplets were born at the third gestation of a 42 years old mother.

All triplets and quadruplets were born before the term set, ranging from 2 weeks up to 1.5 months. We have shown the weight of the triplets, the term of birth in weeks in comparison with the same indices of children who are not twins /new-born/. The thick line connects the monozygotic partners, and the dotted line the dizygotic ones /Fig. 3/. At the end of the first year, from birth we compare the same dimensions with the data about singly born children of the same age. We made the same comparison at 2 years of age too. It is quite clearly seen that with the exception of the quadruplets all triplets studied by us up to 2 years of age, although prematurely born, reach the development of full-term babies who are not twins /Figs 4, 5 and 6/.

In contrast to the partner twins, in the triplets studied by us up to the last examination all children have preserved the differences in the over-all dimensions existing at birth. Often the differences between the monozygotic partners were greater than those of the dizygotic partner /Fig. 7/. This corroborates absolutely the thesis discussed also in connection with our twin investigations that the anthropological features characterizing the physical development obey the objective laws of the multifactorial heredity.

We have the genealogical tree of each family with triplets. In three of our cases the mother is a twin. In the three cases her partner is not alive. One of these cases is interesting for the fact that the sister of the triplet's mother but from a step-mother, gives birth to twin also. In two of the families of the monozygotic triplets there are twins on the mother's side only, and in the third family both on the mother's and father's sides.

Of the nine dizygotic triplets in the families of seven there are twins both on the mother's and father's sides every other generation or so, or in the same generation, but in cousins only.

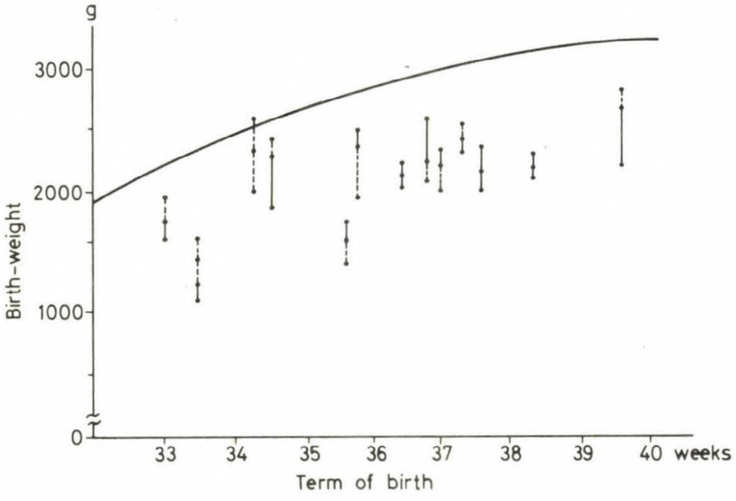
g
3000
2000
1000
0
Birth-weight
33
34
35
36
37
38
39
40 weeks
Term of birth

Fig 3

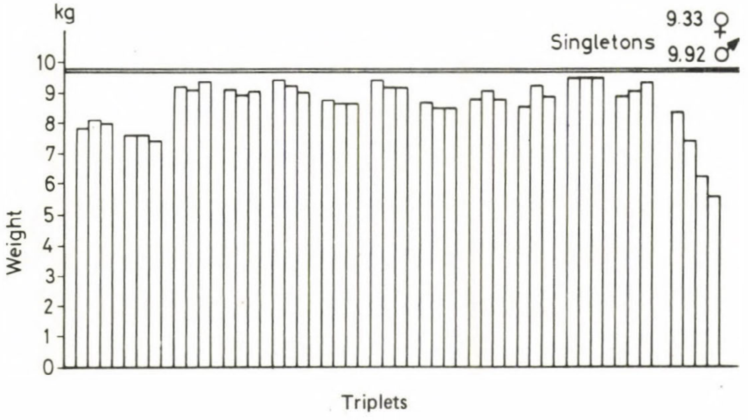
kg
Singletons
9.33 ♀
9.92 ♂
10
9
8
7
6
5
4
3
2
1
0
Weight
Triplets

Fig 4

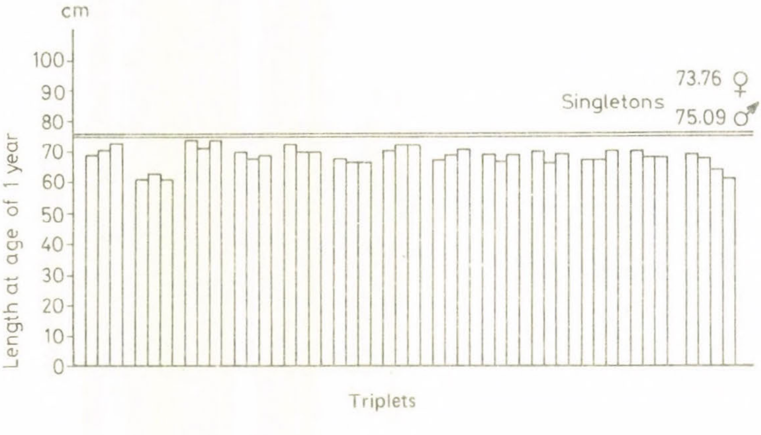
cm
100
90
80
70
60
50
40
30
20
10
0
Length at age of 1 year
Singletons
73.76 ♀
75.09 ♂
Triplets

Fig 5

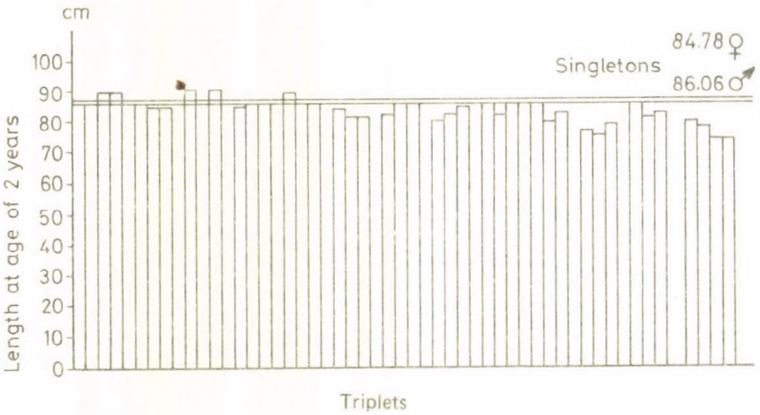
cm
100
90
80
70
60
50
40
30
20
10
0
Length at age of 2 years
Singletons
84.78 ♀
86.06 ♂
Triplets

Fig 6

In their genealogy the quadruplets have twins on the father's side only. The father has a brother and a sister who are twins.

The genealogy picture of the higher multiple births is still more complicated than that of twins. It is rather varied for one to be able to deduce any objective law, because in the dizygotic triplets there is a combination of monozygosity and dizygosity. One thing, however, is indisputable in all triplets included in this paper that there is no family in which the multiparity feature should not have appeared several times in the last generations.

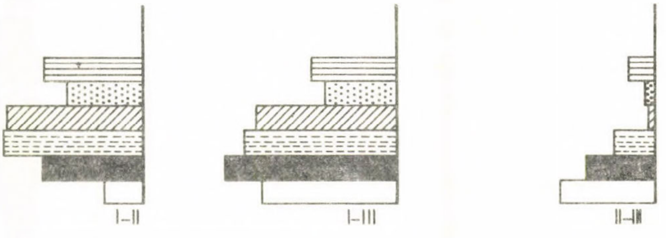

Fig 7

Our investigations on the higher multiple births in Bulgaria during tha past 10-15 years are in full swing. We consider that this combined genetic model will help us in elucidatin some results already obtained by us in twinning studies of many years to settle the complex problems of multiparity heredity in man. At the same time some of the objective laws of the physical development of early childhood and puberity may get an interesting illustration in examination of higher multiple births.

PHYSIQUE

Growth and Development; Physique *Symp. Biol. Hung. 20, (1977)*

APPLYING THE HEATH-CARTER SOMATOTYPE METHOD

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This is a brief review of how the Heath-Carter somatotype method evolved from the Sheldon method and how it is applied. The materials, data and analyses referred to have appeared in publications during the period from 1940 to the present (1976). The volume of literature suggests continuing interest in somatotype as a tool in studies of variations in human physique and performance. It also suggests that some scientists have found at least partial or potential answers to the often asked question: "Of what use is somatotyping?" The literature shows that the Heath-Carter method is used in preference to the original Sheldon method, in preference to the Sheldon trunk index method, and in preference to the several other Sheldon-based somatotype methods. The literature indicates that the Heath-Carter modified method has achieved its goal of creating an open system amenable to continued modifications and adjustments.

The Heath-Carter method was designed as a modification of Sheldon's (1940) method, which had gained widespread attention and had aroused considerable controversy in the course of its twenty-five year history. We (Heath and Carter) believe that in the long history of interest in describing human physical variation the underlying concepts of Sheldon's method provided the most useful and original approach. It may be that Sheldon failed to address the methodological problems involved in finding relationships between somatotype (variations in human physique) and human physical performance because of his quest for relationships between human physique and human behavior (temperament) (the subject of his second publication, Varieties of Temperament, 1942. In any case, investigators, especially those interested in physique and performance, raised cogent and legitimate questions about the reliability and objectivity of somatotype ratings and the "permanence of somatotype". Sheldon defended his method and criteria, which were presented in Varieties of Human Physique (1940), and repeated them essentially unchanged 14 years later in Atlas of Men (1954). As a result, interest in somatotype research had begun to lag in the 1950's, despite early enthusiasm.

From the outset in 1945 the fundamental concept of describing the human species with somatotype ratings based on standardized photographs and anthropometric measurements appealed to me. During the time I worked closely with Sheldon I learned to apply his criteria to somatotype ratings so that my ratings correlated almost perfectly with his. However, the question of reliability of somatotype ratings, the subjectivity of anthroposcopy, and the "fictitious permanence" of somatotype were troublesome. It became clear that a closed system was not suited to describing both sexes at all ages; and that Sheldon's data were confined to cross-sectional samples in the U.S. Sheldon published little on somatotype distributions of women, nothing on children and nothing on longitudinal studies.

Beginning in 1955 I was uniquely fortunate, as somatotype consultant and collaborator in geographically and ethnically diverse studies of both sexes at all ages, to work with data which illuminated the chief problems of somatotype criteria. Clearly the somatotype concept could not be useful without modification. The chief problem was reconciling the incompatible elements of the Sheldon method, which was based upon: 1) seven-point rating scale for three components of physique, 2) ratings no greater than 7 and no less than 1 for each component, 3) totals of the three component ratings no greater than 12 and no less than 9, and 4) tables for the distribution of somatotype ratings on the criterion of height/cube root of weight (with corrections for ages at five-year intervals from age 18). The new data showed that: 1) an open rating scale was required to describe physiques which had not been found previously; 2) that an open rating scale produced ratings with sums greater than 12 and less than 9; 3) that somatotypes change during growth and during adult life; 4) that a single table of distribution of somatotypes on the criterion of height/cube root of weight for both sexes at all ages should be substituted for the series of tables corrected for age (there were no tables for children); and

5) that there is a logical linear relationship between somatotypes and height/weight ratios. The reconciliation of these inconsistencies in the Sheldon method is described by Heath (1963) and by Heath and Carter (1966, 1967.)

Several unusual somatotype series supplied the data needed for the modifications proposed. I applied an open rating scale, with equal appearing intervals, beginning theoretically with zero and having no arbitrary end point, to three series of somatotype data. The first was a U.S. series of obese females (Figure 1) (Seltzer and Mayer, 1964); most of the series were rated higher than 7 in the first component (endomorphy). The second was a series of Manus adult males, Papua New Guinea (Heath, 1973) (Figure 2); many of these were rated higher than 7 in the second component (mesomorphy). The third was a series of adult Nilote males (Figure 3) of Africa (Roberts and Bainbridge, 1963); many of these were rated higher than 7 in the third component (ectomorphy). The Medford Growth Study (Clarke, 1971) showed that between ages 7 and 18 boys have a series of somatotype ratings which change from year to year, and often cannot be predicted accurately. Age corrections for adult somatotypes and height/cube root of weight ratios were not acceptable, partly because in cross-sectional data ratings were based upon anecdotal accounts of height and weight histories at ages 18 to 21, with extrapolations for later ages. Heath-Carter modifications report present somatotypes, or morphophenotypes; they are neither predictions of future somatotypes no estimates of previous somatotypes. The concept of a series of somatotypes for each individual in childhood and in adult life replaced that of one somatotype for a lifetime. In growth studies it is now possible to follow the evolution of adult somatotypes from a succession of pre-adult somatotypes. Subjects of different ages in a reference population can be compared directly, because they are measured on the same measuring scales.

Carter (1971, 1975) in the introduction to his handbook, The Heath-Carter Somatotype Method, summarizes the task of modification: "Heath and Carter further objectified Heath's system by incorporating anthropometric measurements and redefining the component scales." It should be noted here that the Heath-Carter method owes its greatest debt to Parnell (1954, 1958). It was Parnell who suggested using anthropometry in conjunction

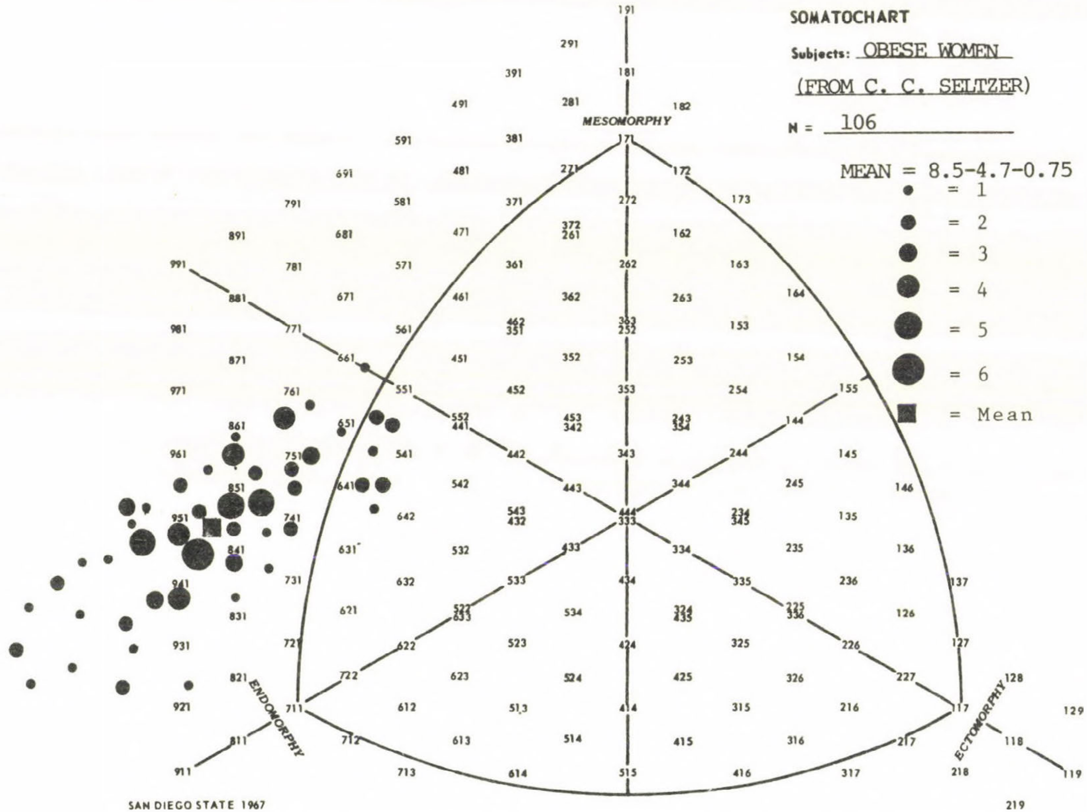

FIG. 1. Somatotype distribution of a sample of obese adult women (U.S.)

with somatotype photographs to objectify somatotype ratings. He used these sets of measurements: 1) triceps, subscapular and suprailiac skinfold thicknesses, in estimating the first component; 2) diameters of humerus and femur, circumferences of arm at biceps and leg at mid-calf, and stature, for estimate of the second component. Parnell used Sheldon's closed 7-point scale for rating somatotype components. He rated the first and third components so as to conform with age-scaled corrections for skinfold thicknesses and height/cube root of weight ratios. We found that skinfold measurements are most valuable in objectifying criteria for first component ratings. Discriminating between the values of first and second components, especially when the differences are small, has been a major difficulty in somatotype rating when it is solely dependent upon anthroposcopy and the criterion of height/cube root of weight. Hunt and Barton (1959) and Damon et al. (1962) recognized that skinfold measurements are valuable in rating the first component.

The Heath-Carter (1967) modified somatotype method consists of Heath's (1963) suggested modifications together with Heath and Carter's (1966, 1967) adaptations of Parnell's (1958) M.4 technique. Carter (1971, 1975) describes modifications which have been developed since 1967, and thus illustrates the advantages of an open system. For example, all measurements and calculations for analysis of somatotype data are now metric. Ross and Wilson (1973) and Ross et al. (1974) have worked out a technique known as the somatotype dispersion distance and the somatotype dispersion index for comparing somatotypes as a whole and not by individual components. This is a breakthrough in analysis of somatotype data, which solves a problem which has puzzled all of us. Hebbelinck et al: (1973) discuss some adjustments which are needed in the somatotyping of children. Other adjustments and modifications, of course, will be made as the Heath-Carter method is more widely used. However, when investigators consider making changes in somatotype method, it is well to observe the difference between modification of an existing method and introduction of a new method. Carter and Heath (1971) make the point that the word somatotyping is a generic term embracing a number of different methods; and that "it is important to note that the trunk index system (Sheldon et al. 1968) bears little relationship to his previous systems, and so must be regarded as another somatotype method."

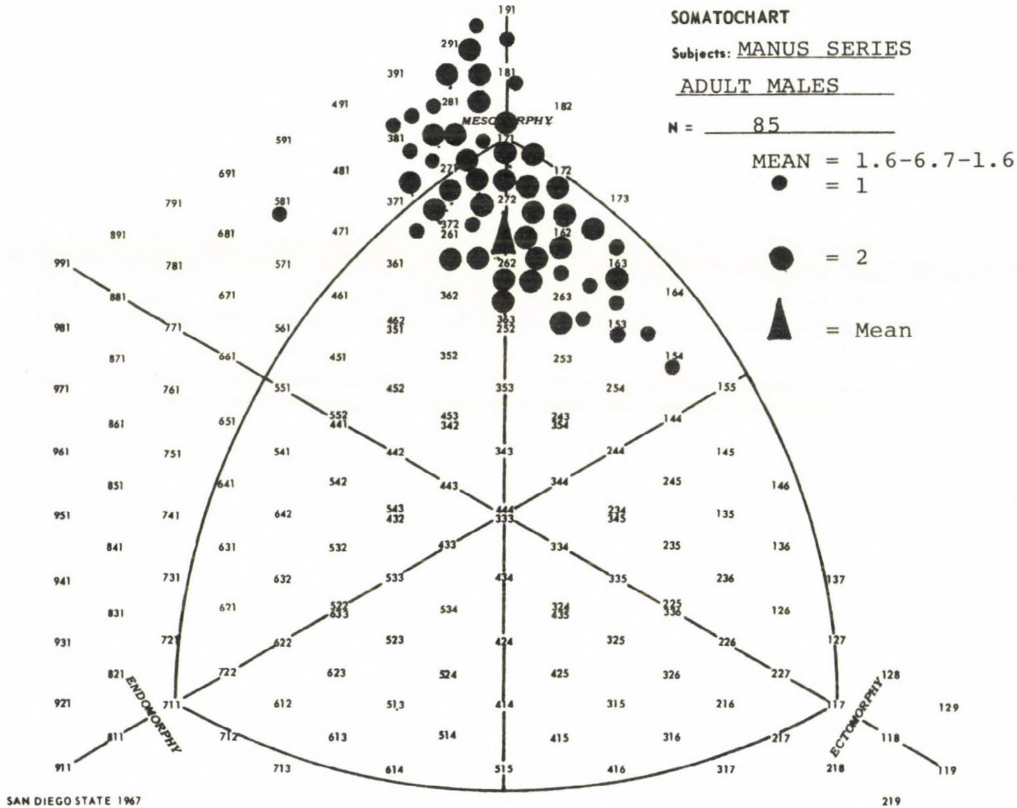

FIG. 2. Somatotype distribution of adult male population of Peri village, Manus Island, Papua New Guinea.

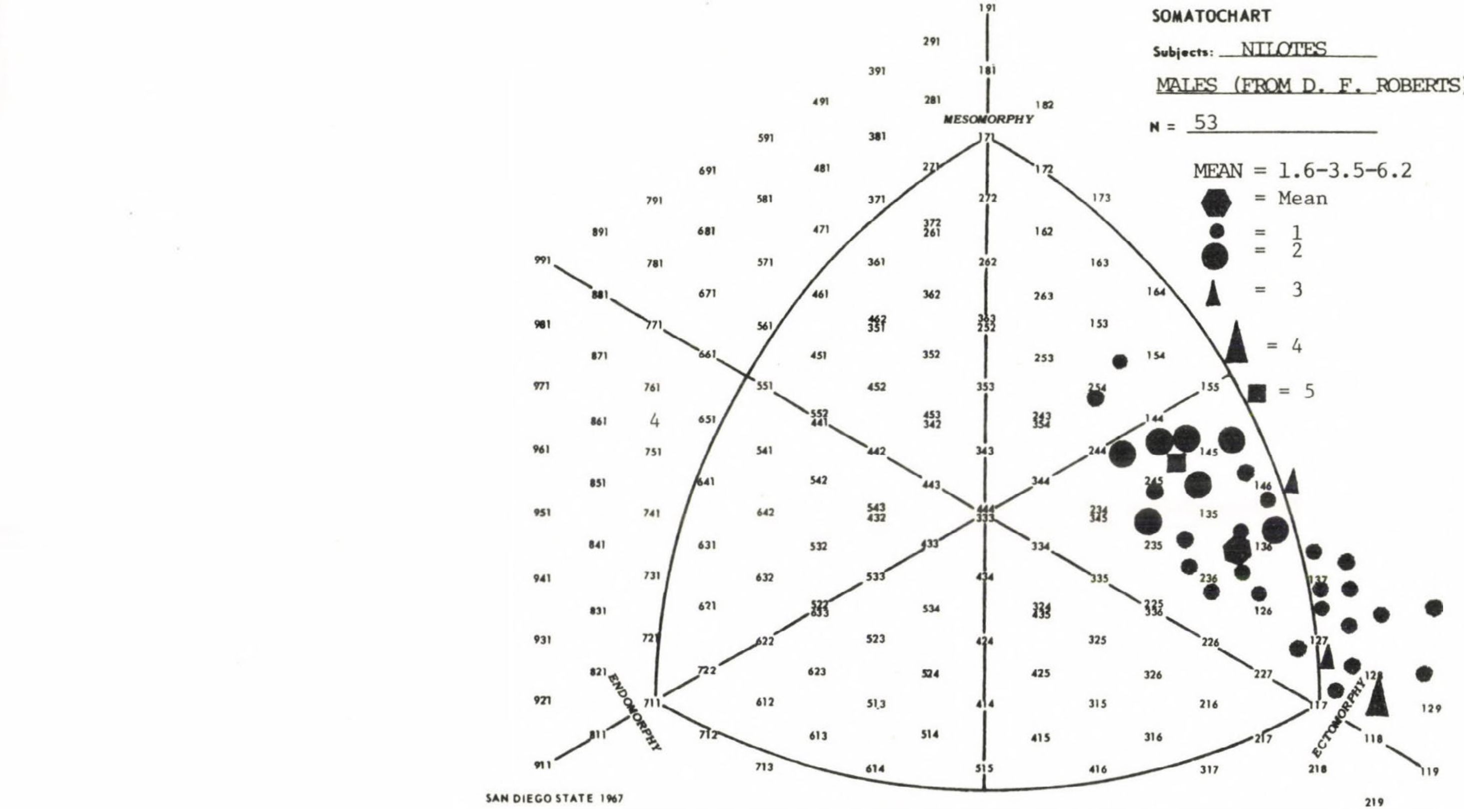

FIG. 3. Somatotype distribution of a sample of adult Nilote males.

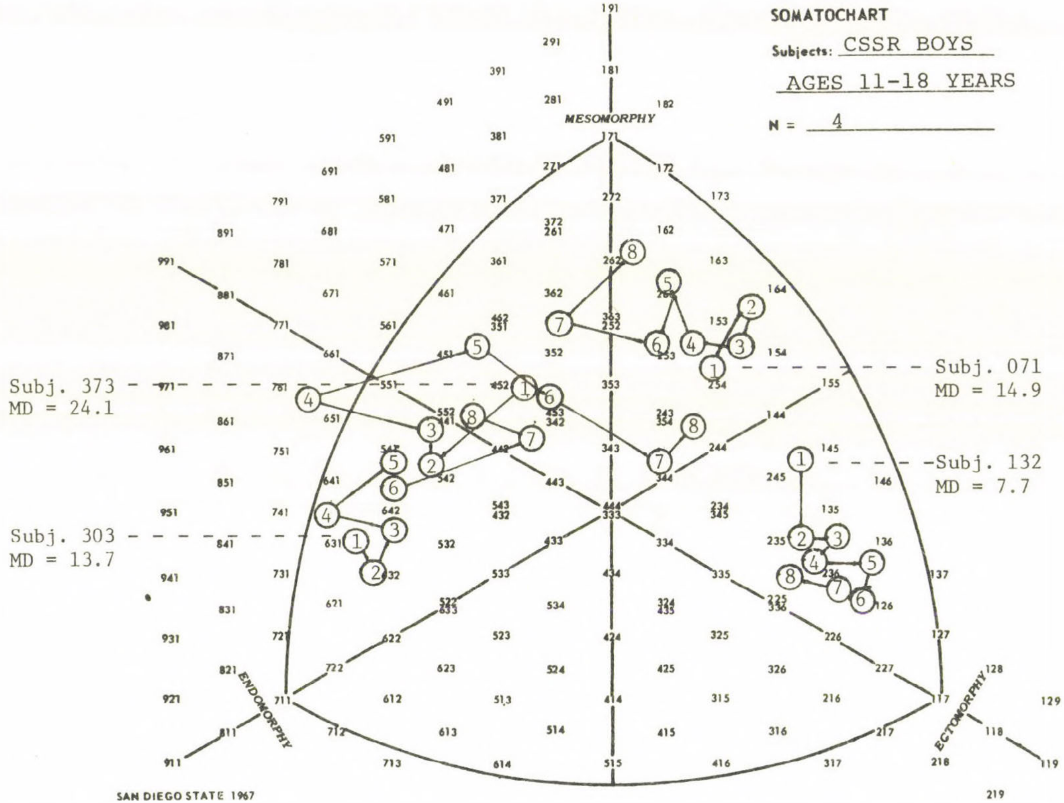

FIG. 4. Somatotypes and migratory distances (MD) of four boys followed from ages 11 to 18. (From Pařízkova and Carter, 1976)

The Heath-Carter method defines somatotype as a description of present morphological conformation. It emphasizes that extremes in each of the three components are found at both ends of continua; and emphasizes that each somatotype should be considered as a whole, that is, that a 2-6-3 and a 2-3-6 should be referred to and <u>thought</u> of in terms of the relative strengths of the three components described in the somatotype rating, and <u>not</u> referred to as a <u>mesomorph</u> and an <u>ectomorph</u>. Somatotype can be defined further as a shorthand description of human physique, which is reproducible, easily learned, and conveys the same meaning and significance to all who use it. The emphasis is on description which reveals similarities and differences between and within samples and populations.

Study (Heath, 1973) (Table 1) of the population of the Manus village of Peri (Papua New Guinea) shows how somatotype data reveal differences <u>within</u> a population, as well as <u>between</u> ethnic groups. As noted above, this study first demonstrated that the adult males included a large number of somatotypes with ratings higher than 7 in the second component. We also found that: 1) the mean for the second component for adult females is higher than for other samples (except women athletes); 2) a marked contrast exists between the narrow distribution for male somatotypes and the somatotypic polymorphism of the distribution of female somatotypes; 3) there is a greater second component sexual dimorphism for the Manus population than we find in other ethnic groups; 4) that somatotypic sexual dimorphism is absent in Manus children under 5 years of age; 5) that between ages 5 and 9 there is a significant shift toward lower first component ratings and higher second component ratings for boys, together with a shift toward higher first component ratings for girls; and 6) that between ages 7 and 17 there is for the boys a marked shift toward the narrow adult male distribution, and for the girls a marked shift toward the polymorphic adult female distribution.

As mentioned above, the Medford Growth Study (Clarke, 1971) showed that at present adult somatotypes cannot be predicted from childhood somatotypes. We have seen that distributions of children's somatotypes at different ages indicate the general trend of somatotypic development

TABLE 1

Means and differences between males and females for

somatotype ratings

SERIES	First component	Second component	Third component
Manus males	1.8	6.7	1.7
Manus females	3.0	4.5	2.4
Differences between males and females	1.2	2.2	0.7
Japanese males	2.9	5.2	2.8
Japanese females	4.5	4.0	2.7
Differences between males and females	1.6	1.2	0.1
Eskimo males	3.9	5.1	1.8
Eskimo females	6.3	4.2	1.3
Differences between males and females	2.4	0.9	0.5
U.S. males	3.3	4.1	3.4
U.S. females	4.5	3.2	3.5
Differences between males and females	1.2	0.9	0.1

during growth, and also show marked increase in somatotypic sexual dimorphism in adolescence. Pařízkova's and Carter's (1976) study of stability of somatotype in Czechoslovakian boys shows individual variations in somatotype changes. In this study the somatochart (Figure 4) shows clusters of somatotypes for four boys from age 11 to age 18. Parizkova and Carter state that: "In order to quantify the somatotype changes between successive years for each subject, the migratory distance (MD) was calculated. The MD is the sum of the SDD's (somatotype dispersion distances) between the successive somatoplots from the first to eighth years" (of the study). The concept of migratory distance is an example of continuing adaptation and modification of the Heath-Carter method. It is an interesting application, which combines quantification (migratory distance) and graphic representation (the somatochart). The MD expresses magnitude of individual change; the somatoplots of the four boys show the directions of change. It also should be noted that this is a study of anthropometric somatotype, because no somatotype photographs were available for rating. Although it is preferable to obtain somatotype photographs together with anthropometric measurements, this study shows that anthropometric somatotypes are feasible.

This report points out the importance of the underlying concepts of the Sheldon method. It shows how the major features of the Heath-Carter somatotype method evolved from the Sheldon method, and how these features were validated and adopted. It shows how recognition of the need for modification and applying modifications went hand in hand. And it points out the nature and uses of modifications and adjustments of the Heath-Carter method, which expand and increase its usefulness.

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SOMATOTYPE OF MALE AND FEMALE VENEZUELAN SWIMMERS

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ABSTRACT

A study has been done about the somatotypes of 34 Venezuelan male and female swimmers belonging to the Francisco de Miranda Swimming Team. Somatotypes ratings were calculated for all performers based on the Heath-Carter Anthropometric - Method. Means, standard errors and standard deviations on the variables Endomorphy, Mesomorphy and Ectomorphy were calculated for both groups. Finally, the individual somatotypes were plotted on somatocharts.

INTRODUCTION

The basic principles of the science of constitution began to develop in the time of Hipocrates. In this period the conexion was established - between body build and behavior.

Of all the variables present in the constitution, physical appearance is the most obvious and for this reason in the last decade there is a renewed interest in the constitution. Reciently, correlationship has been found to exist between it and the performance of athletes. Morphological characteristics of athletes have been studied because competitive sports demands a great deal from the body and therefore one expects to find evidence of the structure - function relationship among athletes. This type of study offers basic information about the morphological characteristics necessary for - each type of sport and the physical differences among individuals who practice different sports.

Even though the concept of somatotype was introduced by Sheldon, - -

Stevens and Tucker in 1.940 (Sheldon, et. al, 1.940) and the consideration of structural and functional characteristics of championship athletes is - part of the base for selection in the sports programs of developed countries, there is an alarming scarcity of anthropometric and somatotipic data on Latin American athletes. The only valuable information on the anthropological structure using anthropometric techniques concerning Latin American athletes is that collected for the Olympic Games in Mexico (de Garay, and coworkers, 1.974) and that being collected on athletes in Cuba.

It should be pointed out nevertheless that an athlete's success can - not be explained only on the bases of anthropometric measurements. Both - genetic and environmental factors must be taken into account.

The purpose of this paper is to report data found on Venezuelan swimmers. This is a pilot study for a research program on the Biotipology of Venezuelan athlets in which other sports as well as swimming will be considered. The frame of reference for this study is the concept of somatotype - defined by Carter as " a description of present morphological conformation. It is expressed in a three-numeral rating, consisting of three sequential numerals, always recorded in the same order. Each numeral represents evaluation of one of the three primary components of physique which describe - individual variations in human morphology and composition. " (Carter,1.975).

REVIEW OF THE LITERATURE

Numerous studies of the biology of athletes have been done. The recent olympic games were a wanderful opportunity for gaining knowledge about the physical constitution of athletes as exemplified by study of Tanner (1.964) and de Garay, et al. (1.974). Especifically about swimming there are the studies by Cureton (1.951), Dupertuis (1.965) and Carter (1.966) among others.

MATERIALS AND METHOD

The sample used in this study consists of 34 swimmers, 22 males and 12 females whose ages vary from 10 to 21 years. The data was collected - during the months of October and November 1.975.

The athletes studied belong to the categories Infantile "A" and "B" and Juvenile "A" and "B" according to the especifications established by - the F.I.N.A. This team won the national championship in 1.974. Moreover, some of the team members hold national records and have performed well in international competitions.

The somatotype rating for each subject was determined using the Heath

Carter Anthropometric Method (Carter, 1.975). Age, height and weight were - obtained. Skin folds of the triceps, scapula and suprailiac were measured. The biepicondylar diameters of the femur and humerus, and the girths of the biceps and calf were taken. Mean, standard error and standard deviation - were calculated for each of these measurements. Finally, the individual - somatotypes were plotted in somatocharts.

RESULTS AND DISCUSSION

Minimum and Maximun values for the three primary components, their - means, standard errors, variances and standard deviations as well as the means of the age, weight and height variables are presented for males in Table N° 1 and for females in Table N° 2.

MEAN VALUES FOR MALE VENEZUELAN (Francisco de Miranda) SWIMMERS

TABLE N° 1

	Mean	Error	Variance	Standard deviation	Min.	Max.
Endomorphy	1.8	0.162	0.581	0.762	1.0	4.0
Mesomorphy	4.3	0.184	0.742	0.862	3.0	5.5
Ectomorphy	3.7	0.213	0.994	0.997	2.0	6.0
Age (Years)	13.8					
Height (cm.)	158.24					
Weight (Kgs)	46.50					
Total Fat. (mm)	19.98					

MEAN VALUES FOR FEMALE VENEZUELAN (Francisco de Miranda) SWIMMERS

TABLE N° 2

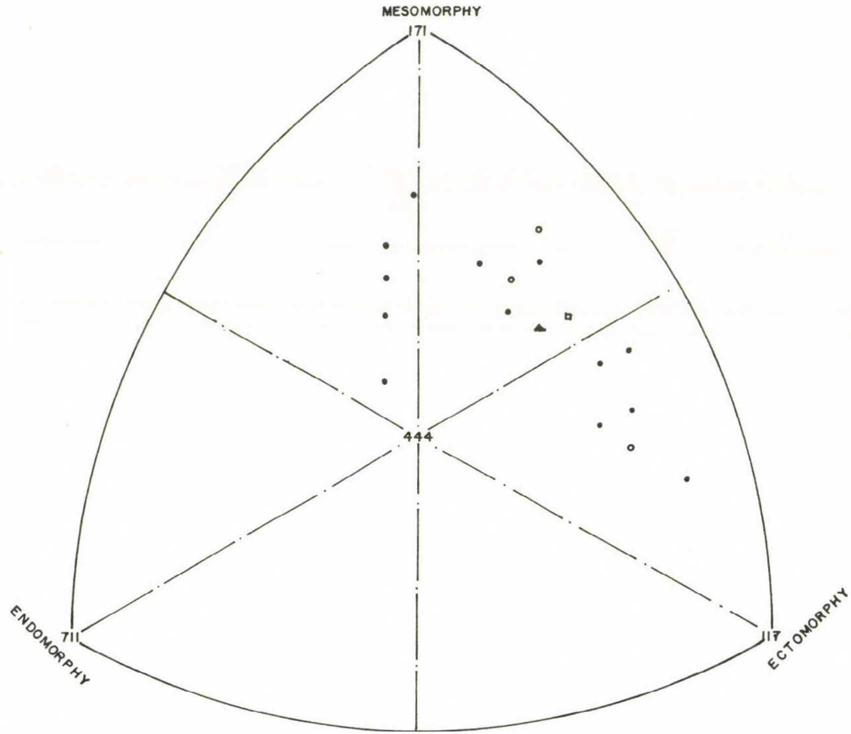
	Mean	Error	Variance	Standard deviation	Min.	Max.
Endomorphy	2.25	0.317	1.205	1.098	1.0	4.5
Mesomorphy	3.78	0.299	1.072	1.036	2.5	5.9
Ectomorphy	3.41	0.368	1.629	1.276	1.0	4.5
Age (Years)	11.11					
Height (cm.)	148.84					
Weight (Kgs.)	40.70					
Total Fat. (mm)	23.50					

SOMATOCHART

SUBJECTS: FCO. MIRANDA SWIMMERS ♂

N = 22

▲ = MEAN

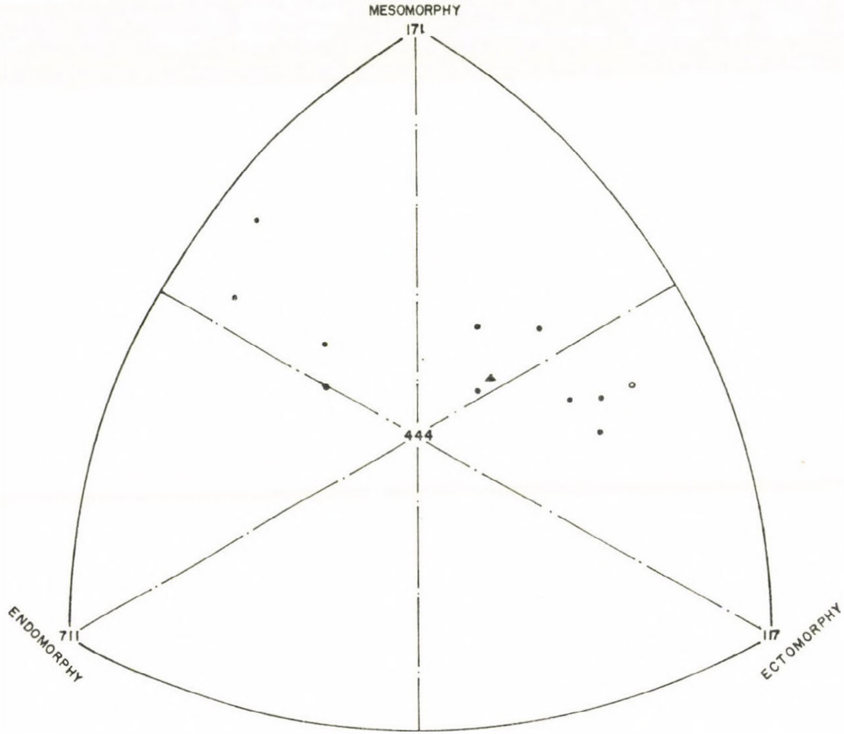


• One individual

o Two individuals

▫ Three individuals

FIG. 1 SOMATOCHART DISTRIBUTION OF FRANCISCO DE MIRANDA MALE SWIMMERS



SOMATOCHART

SUBJECTS : FCO. MIRANDA SWIMMERS ♀

N = 12

▲ = MEAN

• One individual

∘ Two individuals

FIG. 2 SOMATOCHART DISTRIBUTION OF FRANCISCO DE MIRANDA FEMALE SWIMMERS

The sample means for males were 13 years 8 months for age, 158.24 cm. for height and 46.50 Kg. for weight; on the other hand females were 11 years 11 months old stood 148.84 cm. tall, and weighed 40.70 Kg.

The typical male somatotype was 1.8 4.3 3.7. The largest frecuencies for endomorphy fell between 1.5 and 1.9, for mesomorphy between 4.5 and 4.9 and for ectomorphy between 3.5 and 3.9. As a group the males swimmers are mostly meso-ectomorphic (45%); with the next largest group being the ectomorphic mesomorphs, followed by mesomorph-endomorphs, with only one case of balanced mesomorph.

As shown in Figure 1, the somatotipic distribution is located within the mesomorphic and ectomorphic area, above the 551-444-117 line. The somatotipic mean of the group falls within the area delimited by the somatotypes 354,244,144 y 254. No cases of extreme somatotypes were found in the sample even among the best swimmers. Two of the individuals studied hold national records, one of them, a male is 1 4 4 1/2 somatotipically, the other a - female has a somatotype of 3 1/2 4 2.

The typical female somatotype is 2.2 3.7 3.4 . They are also mainly meso-ectomorphs (40%) with a 25% of endomorphic mesomorphs as the second largest group.

It can be observed in the somatochart (Figure N° 2) that the somatotypes are spread out within the mesomorphic and ectomorphic regions. Only one individual is located below the 551 - 444 line. The mean female somatotype 2.2 3.7 3.4 is delimited by the somatotypes 344, 354 and 244.

SUMMARY

This report is presented without detailed statistical analysis be - cause the sample is small and no relationship with other population has - been established. Our knowledge is far for complete; this is only a pilot study of the somatotypes of Venezuelan athletes. The proposed study take into account athletes participating in other sports as well as more swimmers.

Within the limitations of this study we can conclude that:

1. The typical Francisco de Miranda swimmer is 13 years, 8 months - old; 158.24 cm. tall; weighs 46.50 Kgs. and has a somatotype of 1.8 4.3 3.7 . As a group these swimmers are ectomorphic mesomorph.
2. The swimmers are located in the area of the somatochart bounded

by the limits of endomorphic mesomorph, ectomorphic mesomorphs, and mesomorphic ectomorphs.

3. There are no cases of extremes of mesomorphy, the highest value found for the second component is 5 1/2.

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SOMATOTYPES OF CZECHOSLOVAK ATHLETES

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Abstract

Somatotypes of 753 male Czechoslovak outstanding athletes were measured in 1968 - 75. Results are given in a table and in somatocharts. Somatotypes of male athletes participating in the following sports have been rated: gymnastics, weightlifting, bodybuilding, cross-country skiing, downhill skiing, football (soccer), volleyball, basketball, handball, ice hockey, track and field (100 m, 400 m, 800 m and 1500 m, high jump, long jump, shot put, hammer throw), canoeing, wrestling, cycling. In some kinds of sport the best athletes constitute a homogeneous group, while in other sports the athletes differ more as for their somatotype.

Introduction

Somatotype is a morphological precondition of success in a certain kind of sport. This does not mean that anyone having a certain suitable somatotype is bound to excel in the given sport. It is not, however, possible to achieve outstanding performances without having a suitable somatotype. In some kinds of sport the somatotype is a very important factor and the best athletes constitute a homogeneous group from the point of view of somatotype (e.g. gymnasts, weightlifters), while in other sports the subjects constitute a less homogeneous group (e.g. football players, handball players).

Since 1965 we have been rating somatotypes of Czechoslovak athletes (top sportsmen). In the first years we used Sheldon s method consulting the Atlas of Men (1954); since the year 1968 we have used the Heath-Carter somatotype method.

By means of the Heath-Carter somatotype method we have rated more than 900 male and 200 female athletes, more than 600 university students (non-sportsmen) both males and females, more than 500 physical education majors from Prague, 800 randomly selected boys and girls and more than 300 boys and girls participating in various sports.

Procedures

This study deals only with the outstanding Czechoslovak athletes (males) who were measured in the years 1968 - 1975. By outstanding athletes we mean the Ist performance class and the master class including athletes of our national teams. (The Czechoslovak classification of sports performance differentiates IIIrd class, IInd class, Ist class and master class, the last two including the best Czechoslovak athletes.

We used the Heath-Carter somatotype method; the standard photographs were taken as documentary material. In many kinds of sport all the outstanding athletes were measured so that the group could be called a representative one.

Results

Table 1 contains the number of measured subjects, means and standard deviations on endomorphy, mesomorphy, ectomorphy and means for height and weight. Somatotypes of the best athletes in certain sports are also included in the table.

Individual somatotypes were plotted on somatocharts, some of which are presented in Figs 2 and 3. Mean somatotypes of 20 groups of Czechoslovak male athletes are shown in Fig. 1. Our results can be compared with the research of Tanner (1964), Carter (1970), de Garay - Levine - Carter (1974) and others who also measured the somatotypes of sportsmen.

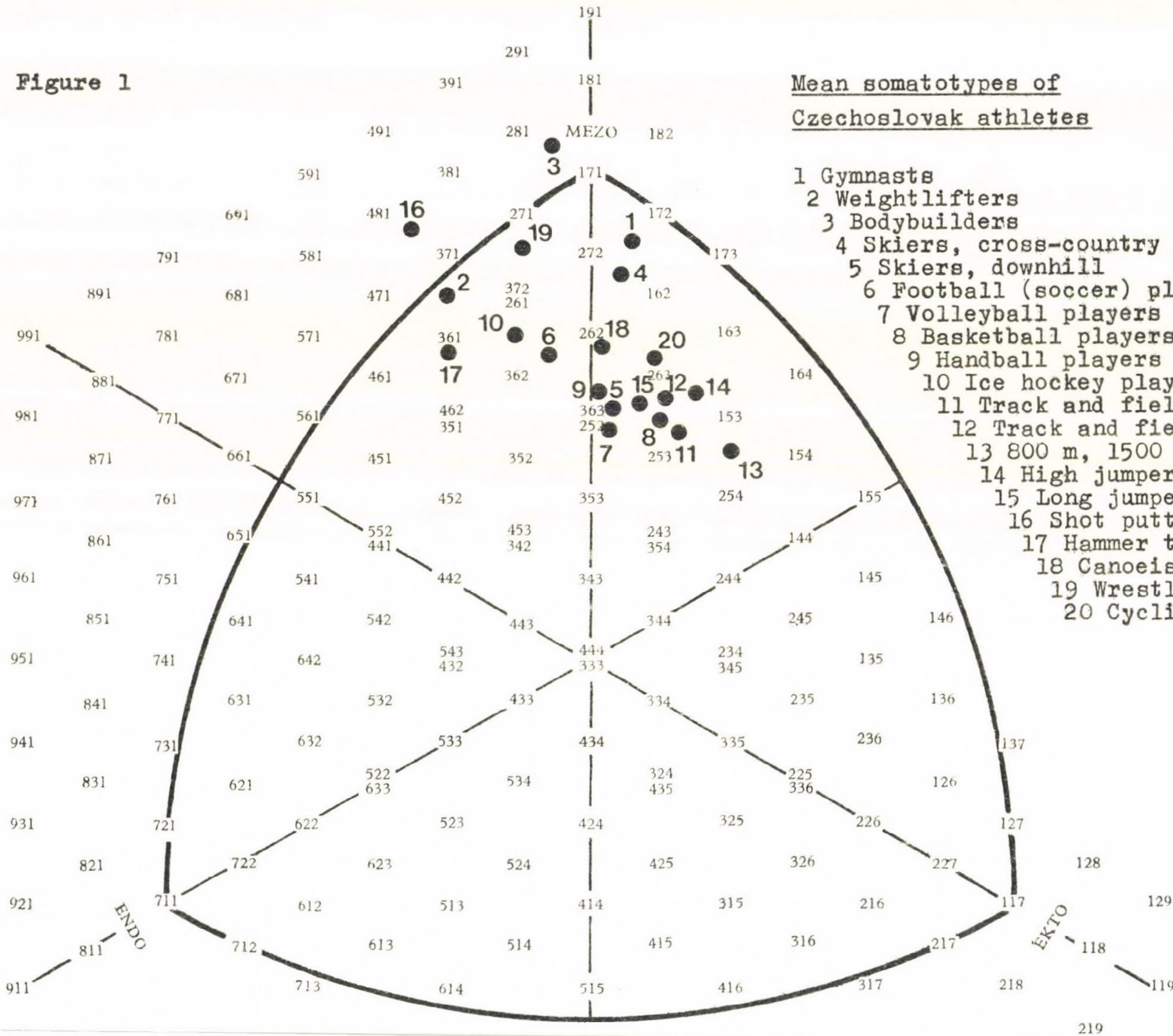
Gymnasts are a very homogeneous group from the point of view of somatotype. The somatotype of the best gymnasts is 1 - 7 - 2 , 1 - 8 - 2 , 1 - 7.5 - 2 . They are high on mesomorphy, with the lower part of their bodies less mesomorphic.

Weightlifters differ according to the weight categories. The superheavy weights (over 110 kg) are not included in our group. All the weight categories are high on mesomorphy. The lower weight categories are low

Table 1 Somatotype, height and weight of Czechoslovak outstanding athletes

Sample	N	Endomorphy $\bar{x}$	Endomorphy s	Mesomorphy $\bar{x}$	Mesomorphy s	Ectomorphy $\bar{x}$	Ectomorphy s	Height (cm) $\bar{x}$	Weight (kg) $\bar{x}$	Somatotype of the best performers
1. Gymnasts	58	1.5	0.56	6.9	0.74	2.1	0.64	169.7	66.5	1.0 - 7.5 - 2.0
2. Weightlifters	48	3.4	1.45	7.2	1.32	1.3	0.50	169.0	77.8	3.0 - 7.0 - 1.0
3. Bodybuilders	102	1.8	0.67	7.9	0.90	1.4	0.55	175.4	78.9	2.0 - 9.0 - 1.5
4. Skiers, cross-country	46	1.7	0.59	6.3	0.68	2.0	0.73	174.6	70.6	1.0 - 6.0 - 3.0
5. Skiers, downhill	12	2.3	0.75	5.6	0.77	2.6	0.68	174.6	70.2	2.0 - 5.0 - 3.0
6. Football (soccer) players	72	2.3	0.86	5.9	0.76	2.0	0.74	176.1	73.5	2.5 - 5.0 - 2.5
7. Volleyball players	108	2.5	0.86	5.5	0.78	2.6	0.87	184.4	81.4	2.0 - 5.5 - 3.0
8. Basketball players	31	2.0	0.68	5.5	0.77	3.1	1.13	190.4	85.1	3.0 - 5.5 - 4.0
9. Handball players	21	2.4	0.82	5.6	0.58	2.6	0.88	180.9	79.1	2.5 - 5.5 - 2.5
10. Ice hockey	91	2.3	0.81	6.0	0.75	1.7	0.74	176.8	78.6	2.5 - 6.0 - 1.0
11. Track and field sprinters	31	1.8	0.68	5.3	0.84	3.0	1.08	177.4	70.1	1.0 - 5.0 - 3.0
12. Track and field 400 m	9	1.8	0.47	5.7	0.58	2.9	0.50	181.7	75.2	1.0 - 5.0 - 4.0
13. Track and field 800 m, 1500 m	9	1.7	0.35	4.8	0.83	3.6	1.01	177.7	67.8	1.5 - 4.5 - 4.0
14. High jumpers	15	1.6	0.39	5.5	0.73	2.8	0.74	183.9	77.3	1.0 - 5.0 - 4.0
15. Long jumpers	10	2.1	0.76	5.7	0.60	2.8	0.84	177.8	72.0	1.5 - 6.0 - 3.0
16. Shot putters	9	3.6	1.61	7.3	0.82	1.0	0.00	184.2	104.0	6.0 - 7.0 - 1.0
17. Hammer throwers	8	3.3	1.58	6.7	1.36	1.6	0.51	181.8	89.7	4.5 - 5.5 - 2.0
18. Canoeists	26	2.0	0.52	5.8	1.03	2.1	0.90	178.7	75.8	1.5 - 6.0 - 1.5
19. Wrestlers	22	2.6	1.92	6.8	1.00	1.6	0.81	171.9	78.4	2.5 - 7.0 - 1.0
20. Cyclists	25	1.5	0.86	5.5	0.29	2.4	0.89	176.9	73.6	1.0 - 5.5 - 3.0

Figure 1



Mean somatotypes of Czechoslovak athletes

1 Gymnasts
2 Weightlifters
3 Bodybuilders
4 Skiers, cross-country
5 Skiers, downhill
6 Football (soccer) players
7 Volleyball players
8 Basketball players
9 Handball players
10 Ice hockey players
11 Track and field sprinters
12 Track and field 400 m
13 800 m, 1500 m
14 High jumpers
15 Long jumpers
16 Shot putters
17 Hammer throwers
18 Canoeists
19 Wrestlers
20 Cyclists

Figure 2

Somatotype distribution of Czechoslovak male gymnasts

(N = 58)

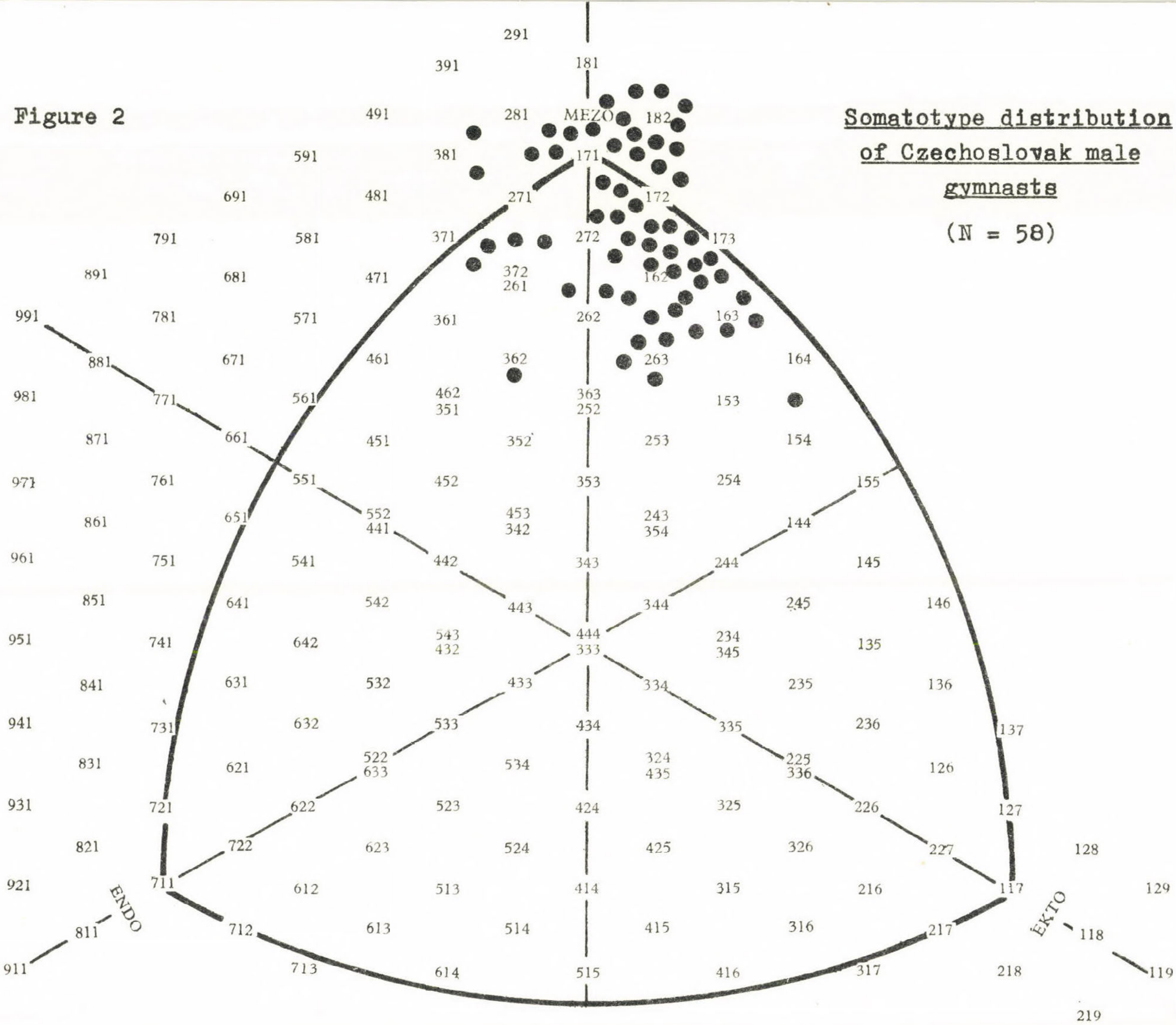
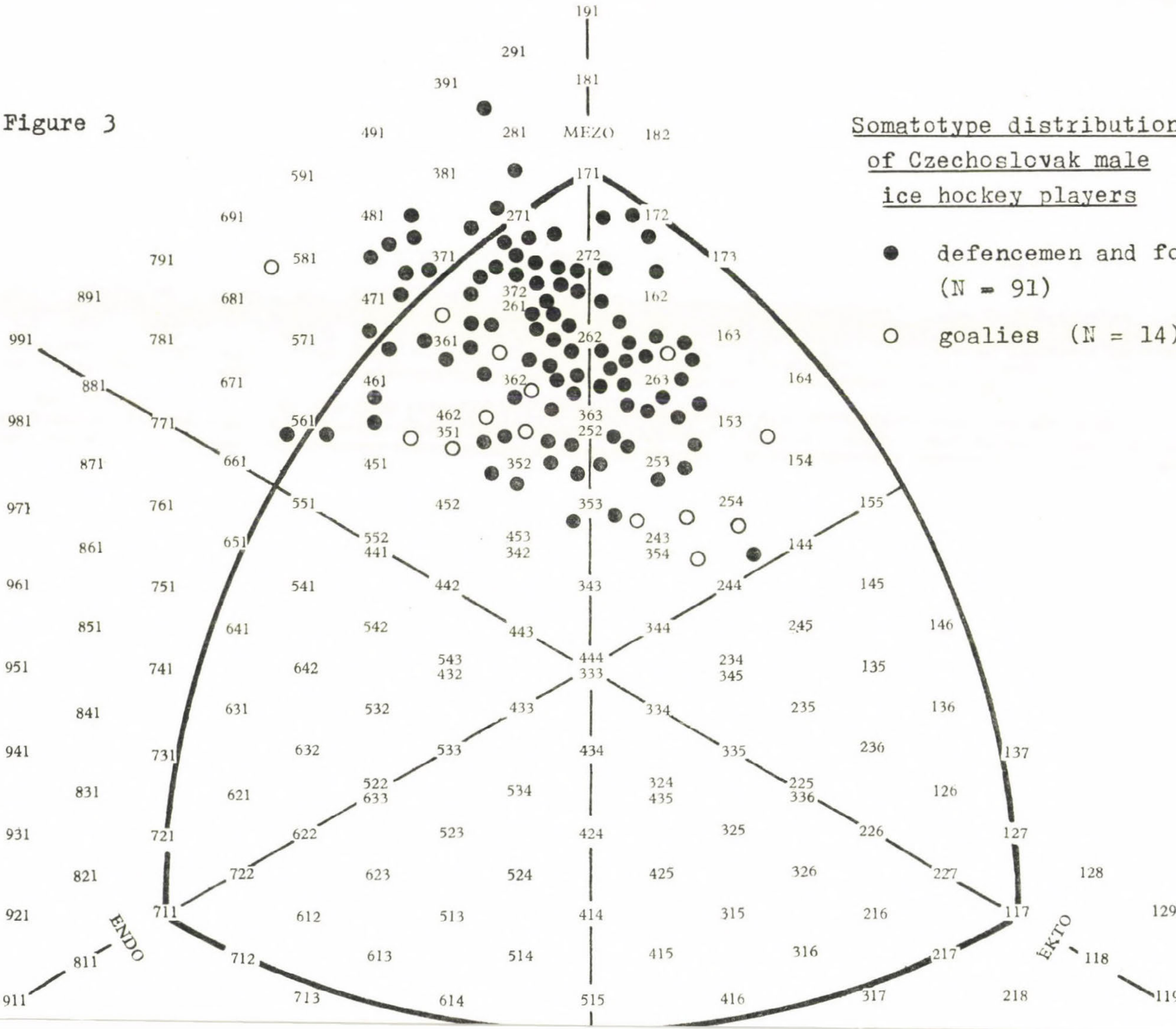


Figure 3



Somatotype distribution of Czechoslovak male ice hockey players

● defencemen and forwards (N = 91)

○ goalies (N = 14)

on endomorphy and rather lower on mesomorphy while the middle and heavy weights have the endomorphic component 3 - 5. A frequent somatotype of the weightlifters is 3 - 7 - 1 , 4 - 7 - 1 . The weightlifters have the relatively shortest extremities of all the athletes, which means a great mechanical advantage in their sport.

Bodybuilders are the most mesomorphic of all the groups, their frequent somatotype being 2 - 8 - 1 , 2 - 9 - 1.5 , 1 - 7 - 1 . High mesomorphy is actually one of the aims of this sport.

Cross-country skiers are mostly high on mesomorphy and low on endomorphy, consistent with their training which is very demanding on endurance. Our group included very mesomorphic types (e.g. 1 - 6 - 2) as well as rather more ectomorphic types (1 - 5 - 3) .

Downhill skiers are less mesomorphic and rather more endomorphic than the cross-country skiers. Two different types were found among the downhill skiers; i.e. the taller ectomorphic mesomorphs (1.5 - 4 - 4), excelling mostly in slalom, and the not so tall mesomorphs (1 - 7 - 2 , 2 - 6 - 2) predisposed rather for downhill racing.

Football (soccer) players are a less homogeneous group from the point of view of somatotype. Several types are successful as football players.

Volleyball players are most frequently high on mesomorphy (5 - 6) which is rarely connected with high body height in the average population. Basketball players are similar as to their type; some of them are rather more ectomorphic than the volleyball players.

Ice hockey players (defencemen and forwards) are very high on mesomorphy and rather high on endomorphy, which aids in increasing their body weight. Greater body weight is very helpful especially in man-to-man struggles. Our best forwards and defencemen have these somatotypes 3 - 7 - 1 , 2.5 - 6 - 1.5 , 3 - 7 - 2 . Goalies can be divided into two different groups of types - endomorphic mesomorphs (e.g. 5 - 7 - 0.5 , 3 - 6 - 1) and the tender types (e.g. 2 - 4 - 3 , 1 - 4.5 - 3.5) .

Track and field athletes have been somatotyped very often. The top sprinters have somatotypes 2 - 5 - 3 or 1.5 - 6 - 2 . 400 m runners are taller, their frequent somatotype being 1 - 5 - 4 or 2 - 6 - 3 . 800 m and 1500 m runners are less mesomorphic, their somatotypes most frequently 1.5 - 5 - 4 . High jumpers are very tall

($\bar{x}$ = 183.9 cm) but nevertheless quite mesomorphic. The somatotype of the best ones is 5 - 5.5 - 3 . Long jumpers are similar to sprinters as to their somatotype. Throwers are endomorphic mesomorphs, the weight putters the most mesomorphic.

Canoeists (long distance racers) who need mostly dynamic strength of arms most frequently have the somatotype 1.5 - 6 - 1.5 , although the more ectomorphic types with long arms are successful as well.

Wrestlers differ, as do the weightlifters, according to their weight category. The low weights are less endomorphic. Mesomorphy of all these athletes is high, the most frequent somatotype is 2.5 - 7 - 1 .

Cyclists are in the most cases ectomorphic mesomorphs. Their most frequent somatotype is 1 - 5.5 - 3 .

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SEXUAL DIMORPHISM IN SPORT BY A SOMATOTYPE I-INDEX

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Since the time of Hippocrates, the classification of body types has been a persistent theme in Art and Science. For the past 35 years, a three component somatotype schema of William H. Sheldon (1940) and modified versions of it have pervaded the literature in human biology. Deutsch and Ross (1976), using a computer augmented literature assembly system, identified about 600 pertinent papers on somatotype gleaned from over 300 different sources.

While the Sheldonian somatotype is still a viable procedure, a modified method by Heath and Carter (1967), more recently discussed by Ross et al (1973) and Carter (1975) has been used with increasing frequency, particularly in studies having to do with exercise, growth, performance and nutrition. The methods are not interchangeable. They represent different orientations to human morphology. The Sheldonian method is based on the concept of a stable somatotype which purportedly relates to the basic morphogenotype of an individual. The Heath-Carter method is fundamentally a phenotypical system. It yields the same kind of three component rating of the physique as the Sheldonian method but, as it is, at any given time, without adjustments for age or sex.

In application of all methods of somatotype analyses, it has been a practice to treat the three components of endomorphy, mesomorphy and ectomorphy independently. Obviously, the magnitude of individual components is of some importance, especially in the identification of groups. For example, the information presented by Heath et al (1968) that the Manus are perhaps the most mesomorphic non-athletically select populations is of some importance, since mesomorphy is the dominant physique characteristic of the group. However, disassembling the somatotype is not without hazard. The role of a 4 in endomorphy in an endomesomorphic 4-7-1 shotputter in providing mass directed to the shot is vastly different to the role of a 4 in endomorphy in a mesopenic 4-2-4 synchronized swimmer where the contribution to performance is mainly one of appearance and buoyancy. For this reason, the interpretation of the same 4 in endomorphy should be in the context of relative dominance and not in intensity of the individual components.

Considering the somatotype as an indivisible gestalt has been discussed by Verdonck (1972) and Borms et al (1972). More recently, in a paper on metaphorical models in the study of human shape and proportionality, Ross (1976) discussed the theoretical basis for somatotype analyses and elaborated on new procedures for comparing individual samples while retaining the essential relationships among the somatotype components for each individual in the samples.

The new procedures assume that any three component somatotype may be represented by a single point on an (X,Y) coordinate grid superimposed over a somatochart described by Carter (1975). This graphic representation models the physique to a point on a Reuleux triangle named after Franz Reuleux (1829-1905). Thus, in the somatochart, the curved triangle is such that the sides of the interior triangle are equal to the widths and the area is a function of width $(\pi \cdot 3^{-\frac{1}{2}})\ w^2$. The scales of the somatochart for the plotting grid are $X:Y = 1 : 3^{-\frac{1}{2}}$.

Under this assumption, the shotputter rating of 4-7-1 is metaphorically its somatoplot (-3, 9) and that of the 4-2-4 synchronized swimmer (0, -4) which were determined by application of the following formulae:

$$x = \mathrm{III} - \mathrm{I}$$

$$y = 2\,\mathrm{II} - (\mathrm{III} + \mathrm{I})$$

Where X and Y are coordinates of the somatoplot, I is the rating of the first component, endomorphy, or relative fatness, II is the rating of the second component, mesomorphy, or relative musculo-skeletal robustness, and III is the rating of the third component, ectomorphy, a relative lankiness or 'stretched-outness'.

Using this convention for locating somatoplots, the distance between any two such plots such as those for the shotputter (-3,9) and synchronized swimmer (o, -4) may be calculated by the Pythagorean formula specified by Ross and Wilson (1973) as follows:

$$SDD_{1-2} = \sqrt{3(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

Where SDD_{1-2} is the somatochart dispersion distance between any two designated somatoplots represented as (X_1, Y_1) and (X_2, Y_2) and 3 is a constant which under the square root sign converts X-units into Y-units thus scaling all somatochart distances to the actual ordinate scale of the somatochart. Thus, the distance in Y-units between the somatoplots of the shotputter and synchronized swimmer was calculated to be 14.0.

A further elaboration of the somatotype dispersion distance (SDD) concept is the somatotype dispersion index (SDI). As shown in the following formula, the SDI is simply the mean somatotype dispersion distance of somatoplots from the mean somatoplot of a sample.

$$SDI = \frac{\sum_{i=1}^{n} SDD_i}{n}$$

Where the SDD's are the somatotype dispersion distances from the mean somatoplot and n is the number of subjects in the sample.

As discussed by Ross (1976) the somatotype dispersion distance (SDD) and somatotype dispersion index (SDI) concepts may be used to derive an I-index to show commonality between samples. Essentially, this is a ratio derived from the intersection of circles drawn with the centres on mean somatoplots and radii equal to SDI_1 and SDI_2 .

In its simplest form the I-index is a function of the area of the intersecting portion of the circles divided by the sum of the areas of the two circles minus the intersecting portion as shown for the three cases summarized in Table I.

Where the circles do not intersect, the I-index equals zero. Where the smaller circle lies wholly within the larger circle, the I-index is 100 times the ratio of the square of the smaller circle SDI_2 to the square of the larger circle SDI_1. Where there is intersection of circles and the area of one circle is not wholly within the area of the other, the following general formula and its derived componenets are applicable. In all instances the subscript (1), refers to the circle with the largest SDI with other dimensions as specified in the general formula and its derivation as follows:

$$I = 100\left[\frac{C_1+C_2}{(A_1+A_2)-(C_1+C_2)}\right]$$

$$C_1 = B_1 - 2P$$

$$P = \sqrt{S(S-SDI_1)\cdot(S-SDI_2)\cdot(S-SDD_{1-2})}$$

$$S = \frac{1}{2}(SDI_1+SDI_2+SDD_{1-2})$$

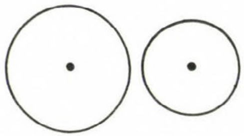
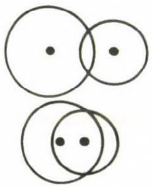
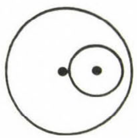
$$B_1 = \frac{\alpha^\circ}{360}.\pi.SDI_1^2$$

$$\alpha^\circ = \frac{360}{\pi}\left[\sin^{-1}\left(\frac{2P}{SDI_1.SDD_{1-2}}\right)\right]$$

TABLE I

CALCULATION OF I-INDEX FOR THREE CASES

WHERE SDI_1 IS RADIUS OF LARGE AND SDI_2 IS RADIUS OF SMALLER CIRCLE.

CASE	DESCRIPTION	CONDITION	FORMULA
	no intersecting	$SDI_1 + SDI_2 \leq SDD_{1-2}$	$I = 0$
	intersecting but one circle not wholly in other	$SDI_1 - SDI_2 < SDD_{1-2} < SDI_1 + SDI_2$	$I = 100 \left[\frac{C_1 + C_2}{(A_1 + A_2) - (C_1 + C_2)}\right]$
	one circle wholly within other	$SDD_{1-2} \leq SDI_1 - SDI_2$	$I = 100 \left[\frac{SDI_2^2}{SDI_1^2}\right]$

$$C_2 = \frac{\gamma^\circ}{360} \cdot \pi \cdot SDI$$

$$\gamma^\circ = 2(180^\circ - \frac{\alpha^\circ}{2} - \beta^\circ)$$

$$\beta^\circ = \frac{180}{\pi}\left[\sin^{-1}\left(\frac{\sin\frac{\alpha}{2} . SDD_{1-2}}{SDI_2}\right)\right]$$

$$A_1 = \pi . SDI_1^2$$

$$A_2 = \pi . SDI_2^2$$

Using the foregoing I-index formulae as an indicator of sexual dimorphism, male and female samples were compared for five sports. Insofar as these subjects may be thought of as being prototypical of the elite, the smaller the I-index, the greater the somatotype sexual dimorphism for the particular sport.

SUBJECTS:

The skaters as discussed by Ross et al (1976) were select senior and junior competitors who were participants in a singles figure skaters training session held at the University of British Columbia in the summer of 1974. The basis of selection was competitive points won in Canadian Amateur Figure Skating Association sanctioned competitions at regional, national and international levels. A group of Alpine skiers was studied shortly after the skaters at a ski training camp held at Whistler Mountain, B.C. At the time, all the skiers in this sample were members of Canada's World Cup team. The swimmers, divers and gymnasts were participants in the 1968 Mexico Olympic Games as sampled and reported by de Garay, Levine and Carter (1974) with further analyses on the swimmers and divers by Hebbelinck, Carter and de Garay (1975).

METHOD:

Somatotypes for the subjects in this study were calculated by computer programs from anthropometric data obtained by anthropometrists trained by and under the supervision of the two senior authors. From the individual somatotypes, I-indices were calculated between male and female samples by a computer program designed by Roth.

RESULTS:

The mean somatotype and somatotype dispersion index for each sex and the somatotype dispersion distance between the male and female mean somatoplots for each sport are shown in Table II.

The degree of homogenity of each of the samples is indicated by the magnitude of the somatotype dispersion index (SDI), the smaller the SDI, the greater the homogenity. Thus, for men, the most homogeneous group were the skaters with an SDI of 2.09, followed by divers 2.21, gymnasts 2.42, skiers 2.48, and swimmers 2.57. For females, the most homogeneous were the gymnasts with an SDI of 1.87, followed by divers 2.29, skaters 2.42, swimmers 3.07, and skiers 3.56.

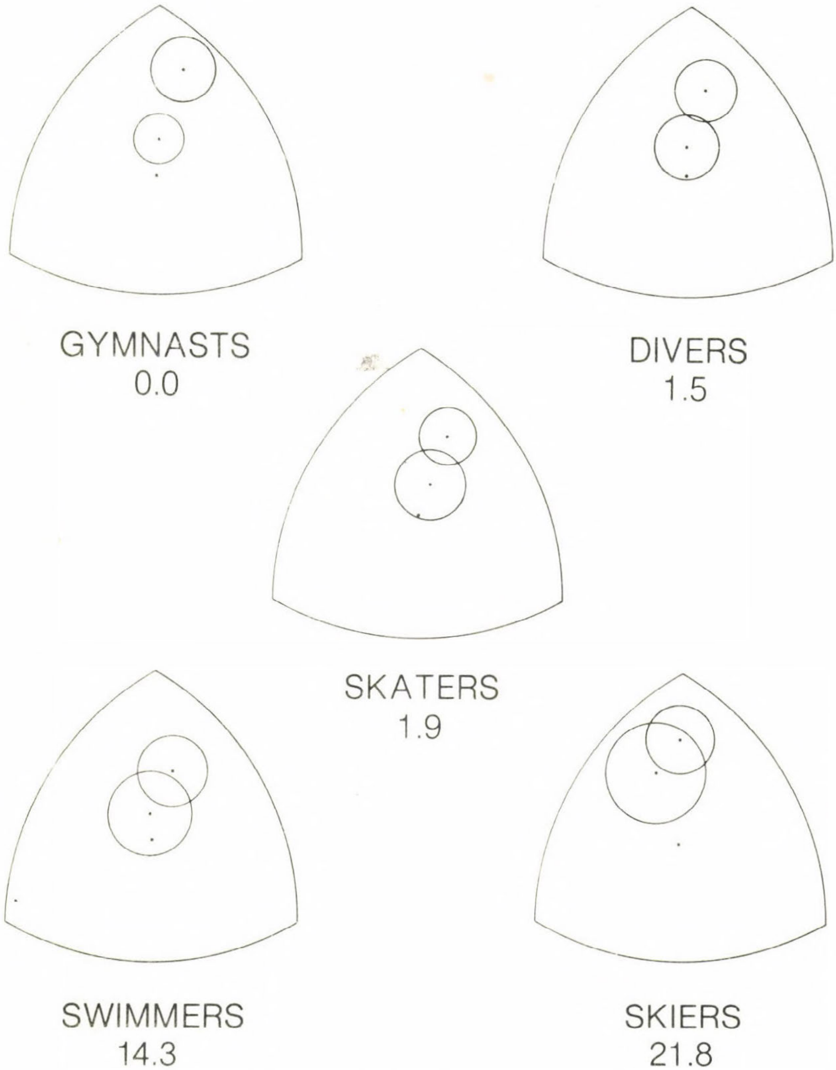
The somatochart distance between male and female somatoplots is indicated by the somatotype dispersion distance (SDD).

TABLE II

SEXUAL DIMORPHISM IN SPORT BY SOMATOTYPE I-INDEX

SPORT	SEX	n	MEAN SOMATOTYPE	SDI	SDD m-f	I-INDEX m-f	T^2VALUE*
SKATERS	m	12	1.8 - 5.0 - 2.9	2.09	3.87	1.90	19.88*
	f	18	2.8 - 3.8 - 3.0	2.42			
SKIERS	m	12	2.0 - 5.7 - 2.1	2.48	3.06	21.83	14.39*
	f	9	3.0 - 4.9 - 1.9	3.56			
SWIMMERS	m	60	2.1 - 5.0 - 2.9	2.57	3.27	14.30	39.30*
	f	27	3.1 - 4.0 - 3.0	3.07			
DIVERS	m	7	1.9 - 5.4 - 2.7	2.21	4.11	1.52	12.58*
	f	16	2.9 - 4.0 - 2.9	2.29			
GYMNASTS	m	28	1.4 - 5.9 - 2.4	2.42	5.48	0.00	39.95*
	f	21	2.7 - 4.2 - 2.8	1.87			

SDI - somatotype dispersion index, SDD - somatotype dispersion distance between mean male and female somatoplots, I-index between male & femal distributions, T^2 value-Hotelling T^2 test, *-signifant at 1% level. (Ross, Carter, Roth, Willimczik 1976).



I-INDEX DIAGRAMS SHOWING SOMATOTYPE SEXUAL DIMORPHISM IN SPORT

(in all cases top circle male)

Fig. 1.

The smallest male-female SDD was 3.06 for skiers followed by swimmers 3.27, skaters 3.87, divers 4.11 and gymnasts 5.48.

As shown in Table II, the SDI and SDD information was combined in an I-index to show the commonality of male and female samples for each sport. The smaller the I-index, the greater the somatotype sexual dimorphism. The most dissimilar group was the gymnasts who had an I-index of 0.00, followed by the divers 1.52, skaters 1.90, swimmers 14.30 and skiers 21.83.

Since the somatotype may be represented as a somatoplot, it is possible to test the significance of the difference between samples using a multivariate technique where the coordinates for each somatoplot may be treated as paired scores. In this situation, the vectors from the mean somatoplot of each sample may be tested by application of Hotelling T^2 test where:

$$T^2 = n D^2$$

Where n is $n_1 \cdot n_2 / n_1 + n_2$ and D^2 is the value for the distance between sample 1 and sample 2 which have mean somatoplots $(\overline{X}_1, \overline{Y}_1)$ and $(\overline{X}_2, \overline{Y}_2)$ respectively.

D^2 may be calculated by:

$$D^2 = S_{11}^{-1}(\overline{X}_1 - \overline{X}_2)^2 + 2 S_{12}^{-1}(\overline{X}_1 - \overline{X}_2)(\overline{Y}_1 - \overline{Y}_2) + S_{22}^{-1}(\overline{Y}_1 - \overline{Y}_2)^2$$

Where Sij^{-1} are the elements of the inverse covariance matrix.

To test the significance of the T^2 values for male and female samples for each sport, the obtained T^2 values were multiplied by the size factor $n_1 + n_2 - 3 / (n \ +n_2 -2)\ 2$. To be significant at the one percent probability level the obtained T^2 had to equal or exceed $F_2; n_1 + n_2 - 3; 0.01$. In all instances, the obtained F - values exceeded the critical value leading to the rejection of the null hypothesis and the acceptance that the male-female distributions for each sport were significantly different.

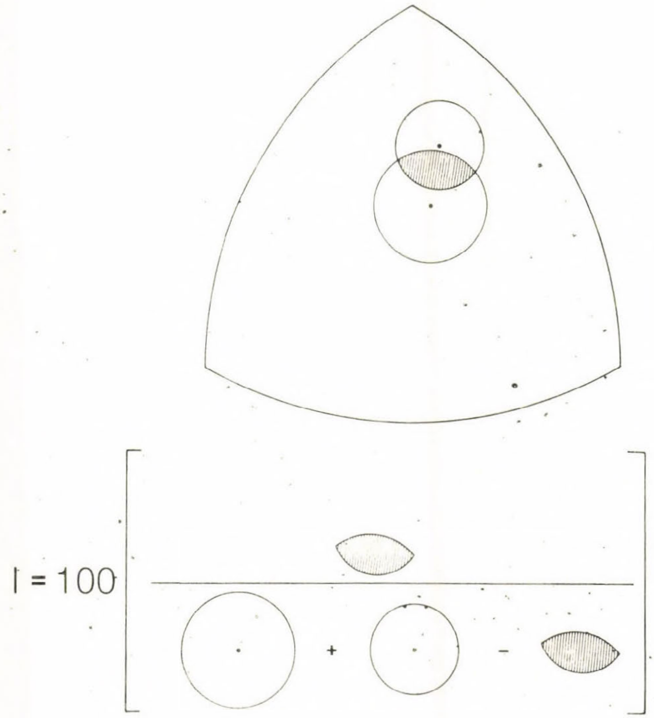


Fig. 2.

CONCLUSIONS:

From analyses based on somatotype dispersion distances, somatotype dispersion indices, I-indices and Hotelling T^2 test, somatotype sexual dimorphism of elite athletes in each of five sports was quantified and tested for significance.

For the sports selected, sexual dimorphism was greatest between male and female gymnasts followed by divers, skaters, swimmers and skiers. While the latter four of the five sports had some overlapping of the male and female SDI circles, the male-female distributions for each were significantly different.

The analytic procedures used in this paper are proposed as general tactics for use in human biology to compare somatoplots of sample distributions. These procedures preserve the integrity of the somatotype as a physique gestalt.

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APPLICATION OF THE SOMATOTYPE ATTITUDINAL DISTANCE TO THE STUDY OF GROUP AND INDIVIDUAL SOMATOTYPE STATUS AND RELATIONS

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I. INTRODUCTION

Since its inception the somatotype rating system posed problems to researchers trying to use it as an instrument in the study of human biology. Besides the difficulties in getting visualized the 3 components, the quantitative analysis has for years been restricted to percentage distributions of existing types or to the study of separate component values. The latter approach limited an effective use of the somatotype concept, as it violated the basic idea of the somatotype as being a totality, a Gestallt.
Recently attempts have been made to meet this basic requirement by new techniques such as dispersion indexes (Ross et al. 1973, 1974, 1976) and category comparisons (Walker 1962, Verdonck 1972, Duquet et al. 1975). According to Ross and Wilson (1973), the dispersion index technique is based on the distance, measured in component units, between two somatoplots or points plotted on Sheldon's somatochart, each representing a certain somatotype. From this so-called Somatotype Dispersion Distance (SDD), a series of other descriptive statistics can be calculated, such as the Somatotype Dispersion Index (SDI), which is the SDD group mean. The variance of the individual points around this mean permits statistical analysis of the somatotype data (Ross et al. 1974, 1976).
There is, however, a distinct difference between a somatotype and its projected value or somatoplot. In our opinion, the use of somatoplot distances may lead to a distorted view of somatotype relationships, and cause false deductions. The purpose of the present study was to show the conceptual error and the limitations of the somatotype dispersion technique, and to propose a more valid and reliable substitute to it.

II. LIMITATIONS AND ERRORS OF THE DISPERSION TECHNIQUE

The dispersion technique departs from two basic assumptions or premises (Ross, 1967) :

1. a somatotype is completely embodied by the corresponding somatoplot
2. dispersion distances measure changes or differences in relative dominance of the somatotype components

The first premise is wrong. Sheldon's somatochart is only a 2-dimensional illustration of the spatial, 3-dimensional relationship of possible somatotypes (Sheldon, 1940). It is obtained through orthogonal projection of these 3-dimensionally determined points on a plane that goes through the points with XYZ coordinates (1,1,7), (1,7,1) and (7,1,1). In fig. 1a, the traditional triangle of fig. 1b has been rotated slightly to illustrate the 3-dimensionality of the examplified somatotype (Duquet et al. 1975). The somatochart used by Petersen (1967) is another example of a different way to illustrate the spatial relationships of somatotypes. We can easily imagine somatotypes displayed on the coordinate system of fig. 2, which is at first difficult to visualize, but has the advantage of showing somatotype relations in an undistorted way.

The use of the traditional triangle offers some advantages. It gives the exact limits of the 13 gross dominance groups as defined by Carter (1975). It also indicates the shift towards more extreme or more central types, for types positioned on a line going through the midpoint of the system. The Sheldon triangle fails, however, if more refined information, like f.i. intraclass variation, is required. The reason is obvious : one plot of a 2-dimensional system must necessarily represent the location of more than one 3-dimensional component combination or somatotype. Each of these different component combinations, although projected on one single spot of the 2-dimensional system, is unique in itself. They represent more or less similar looking but definitely different types, with often different dominances. For this reason a point on a somatochart can give some information, but fails to embody completely a certain somatotype rating. Mathematic treatment of the X-Y coordinates of points on a somatochart leads to a deliberate, uncontrollable, irrecoverable loss of information, which is not compensated by any gain or new insight.

While the question whether a distance between X-Y somatoplots can fully represent a 3-component rating can definitely be answered in a negative sense, the discussion could be moved to the assumption that somatoplot

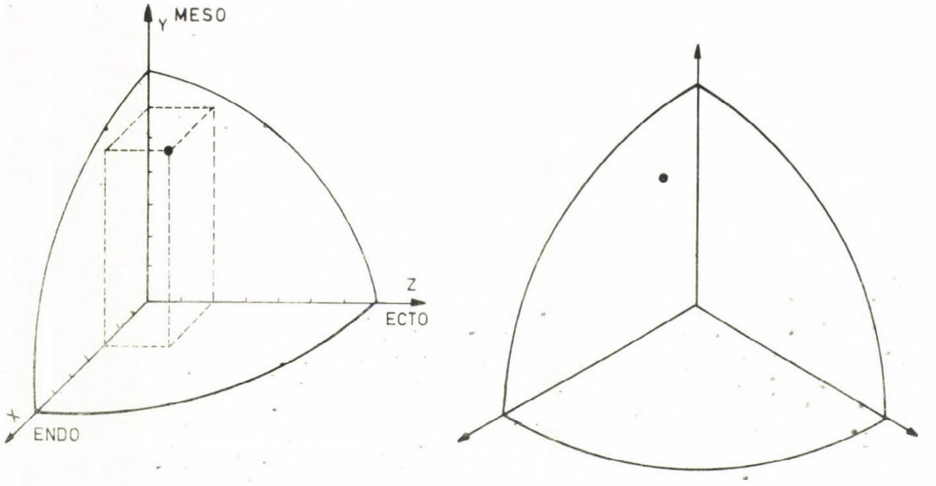

Fig. 1a and 1b : An illustration of the spatial position of somatotype 3-6-2 (1a, left) and the traditional presentation of it in the Sheldon triangle (1b, right).

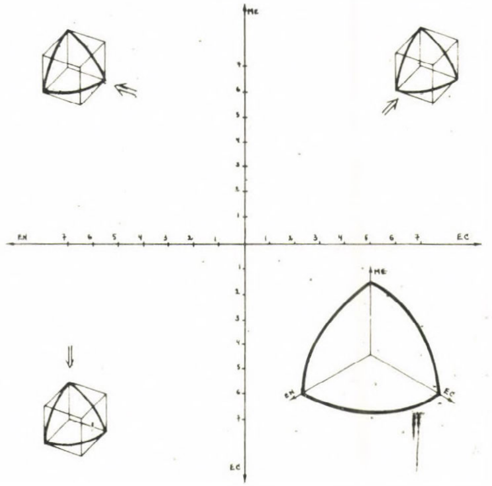

Fig. 2 : A coordinate system which gives a complete information on the spatial configuration of somatotypes.

distances indicate changes in relative dominance (Ross 1976). Since nobody ever gave an exact definition of relative dominance, measuring it must already be difficult to accomplish.

In essence, each existing different somatotype has its own and unique dominance situation, except perhaps for the somatotypes 3-3-3 and 4-4-4. Each change in somatotype is a change in dominance. The distance between two points, be it measured in 2 or in 3 dimensions, gives the magnitude or intensity of the somatotype or dominance change. It gives no information on the direction of that change. However, this direction of change is as important as the magnitude. It does not tell us if a type is more central or more extreme than another type, neither can it recognize a complete dominance switch from an intercategory variation. In short, a distance between 2 points measures only one aspect of dominance change.

Therefore, it seems a questionable procedure to base a whole evaluation system on the premise that a 2-dimensional somatoplot embodies completely a 3-dimensional 3 component somatotype rating. The range of error, inherent to the 2-dimensional dispersion technique, is limited by the number of really existing somatotypes. Nevertheless, instead of using a formula based on inadequate projected values, it is more rational to measure the real somatotype distance, using the original component values directly, in an analogous formula.

III. THE SOMATOTYPE ATTITUDINAL DISTANCE

To differentiate the present 3-dimensional distance between somatotypes from the dispersion technique, the Somatotype Attitudinal Distance or SAD has been introduced.

The SAD may be obtained from the following formulas :

$$SAD_{A,B} = \sqrt{(I_A - I_B)^2 + (II_A - II_B)^2 + (III_A - III_B)^2} \qquad (1)$$

or :

$$SAD_{A,B} = \sqrt{\sum_{i=I}^{III} \Delta^2_{(A,B),i}} \qquad (2)$$

where : I_A, II_A, III_A are the 3 component values that constitute somatotype A

I_B, II_B, III_B are the 3 component values that constitute somatotype B

Δ is the difference between corresponding components of the somatotypes A and B.

The following example illustrates the calculation of the SAD between 2 somatotypes. It also shows the inadequacy of the SDD technique which attributes in this case a same SDD value to different dominance changes.

somatotype		somatotype	SAD		SDD
1 - 6 - 2	$\leftrightarrow$	1 - 6 - 3	1	($\sqrt{0^2 + 0^2 + 1^2}$)	2
1 - 6 - 2	$\leftrightarrow$	2 - 7 - 2	1,4	($\sqrt{1^2 + 1^2 + 0^2} = \sqrt{2}$)	2

If the SAD between an individual somatotype and a group is needed the following formula can be used :

$$SAD_{X,A} = \sqrt{(I_{\bar{X}} - I_A)^2 + (II_{\bar{X}} - II_A)^2 + (III_{\bar{X}} - III_A)^2} \qquad (3)$$

where : I_A, II_A, III_A are the 3 component values that constitute somatotype A

$$I_{\bar{X}} = \frac{1}{n} \sum_{i=1}^{n} I_i$$

$$II_{\bar{X}} = \frac{1}{n} \sum_{i=1}^{n} II_i$$

$$III_{\bar{X}} = \frac{1}{n} \sum_{i=1}^{n} III_i$$

For the reasons previously explained, to measure somatotype dominance change cannot be obtained from the insufficient dominance information of a true distance between two points.

A first possible application consists in the longitudinal follow-up of the somatotype "trace" of an individual, and calculating the magnitude of the somatotype changes. In many cases, this technique will become more valuable if, in addition, dominance changes are described in a qualitative way. Another effective use lies in describing and comparing somatotype group configurations. For this purpose, the SAD possibilities may be explored by adding basic statistical elements similarly as it was the case for the SDD technique (Ross et al. 1974, Ross 1976).

IV. ADDITIONAL TECHNIQUES : SAM, SASD, SVC

Since the Somatotype Attitudinal Distance is a one-dimensional variable on a ratio scale, all usual statistical treatments can be carried out if the proper statistical data requirements are met.
This means one can calculate and then use parameters such as a SAD group mean, which will be called the Somatotype Attitudinal Mean (SAM).
The dispersion of the somatotypes about the mean of their distances to the somatotype group mean (in other words : the dispersion of the deviations from the mean somatotype), can be expressed in a Somatotype Attitudinal Variance (SAV) or a Somatotype Attitudinal Standard Deviation (SASD).
The relative dispersion with respect to the mean deviation can, if needed, be expressed as a Somatotype Variation Coefficient (SVC).
The parameters may be obtained from the following formulas :

$$\mathrm{SAM} = \frac{1}{n} \sum_{i=1}^{n} \mathrm{SAD}_i \qquad (4)$$

$$\mathrm{SASD} = \sqrt{\mathrm{SAV}} = \sqrt{\frac{\sum_{i=1}^{n} (\mathrm{SAD}_i - \mathrm{SAM})^2}{n}} \qquad (5)$$

$$\mathrm{SVC} = \frac{\mathrm{SASD} \times 100}{\mathrm{SAM}} \qquad (6)$$

Applications of these techniques are manifold. The possibilities of the single Somatotype Attitudinal Distance can be expanded from studying time series of individual somatotype displacements or traces to descriptions of location, central tendency and absolute or relative dispersion of a group. Distances can be measured between individual ratings, between group ratings or between an individual and a group rating. If correctly used, this

technique can lead to the study of overlapping of groups or the similarity between them. Another important application is to measure how closely an individual's rating is related to that of a given group, to decide even if the individual's rating can be regarded as a member of that group, which could be an important matter in sports counseling.
The researcher who intends to use the present techniques should, however, be fully aware of the specific meaning, advantages and also limitations of the basic SAD concept. He should for himself decide which formulas to use, and which to add to complete his analysis.

V. CONCLUSIONS

The Somatotype Attitudinal Distance was introduced to replace the Somatotype Dispersion Distance. Together with its derived values, it may become a useful tool in studies of human biology whenever a 3 (or more) component body type system is involved.

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ANTHROPOMETRY AND PHYSIQUE TYPE OF FEMALE MIDDLE AND LONG DISTANCE RUNNERS, IN RELATION TO SPECIALITY AND LEVEL OF PERFORMANCE

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ABSTRACTS

Anthropometric data were gathered on 33 outstanding female European middle and long distance runners who participated in the European championships. These were compared with those of 33 Belgian runners and 33 Belgian physical education students.

Thirty measures were taken, from which derived measures, indices, and somatotype were developed. A total of 52 measures was included in the analysis.

The European middle distance runners although about the same height as the reference group of physical education students /165 cm/, had longer legs, shorter sitting height, broader hips, larger chest diameter hips, larger chest diameters, and smaller upper arm and thigh girths. They weighed less, had a lower percent body fat and less lean body mass. Their typical somatotype was 2.0-4.0-3.5.

The mean measures of the Belgian middle distance runners tended to fall between those of the European sample and the reference group. The typical somatotype of the Belgian middle distance runners was 2.5-3.5-4.0.

The European long distance runners, although similar in height, showed mean values in other measures farther removed from the reference group than those of the European middle distance runners. Their leg lengths were relatively greater, hips broader, girths smaller, and weight, percent fat and

lean body mass were less. Their typical somatotype was 1.5-3.0-4.0.

The Belgian long distance runners were shortest group studied, with a mean height of 161 cm. Other measures tended toward lower mean scores, although hip width, upper arm girth, thigh girth, and percent fat showed mean values falling between the European long distance runners and the reference group. The typical somatotype of the Belgian long distance runners was 2.0-3.5-3.5.

The somatotype distributions of the various groups were analyzed using Duquet's somatotype attitudinal distance /SAD/ and somatotype attitudinal mean /SAM/.

INTRODUCTION

Successful athletes are often pictured in terms of physical stereotypes. If one thinks of sports such as weightlifting, basketball, swimming, highjumping, or gymnastics, specific physique types come to mind. If one considers female distance runners, the stereotype /Fig. 1/ which may be envisioned is one of a slender girl with relatively long legs, narrow hips, matchstick arms, and a small head. She may have a normal thorax but it will seem smaller because the breasts will be poorly developed. In fact the total absence of any significant fat deposits is a feature of this stereotype.

Most stereotypes are founded on at least a particle of truth and all stereotypes should be examined carefully before being accepted or rejected. This study was undertaken to explore the validity of the stereotype for female distance runners, considering their specialities and degree of proficiency. A working hypothesis was as follows: /1/ Successful female distance runners will show physique characteristics different from those of unselected athletic females.
/2/ These differences will be more pronounced among more proficient than among less proficient performers.
/3/ These differences will be more pronounced among long distnace than among middle distance runners.

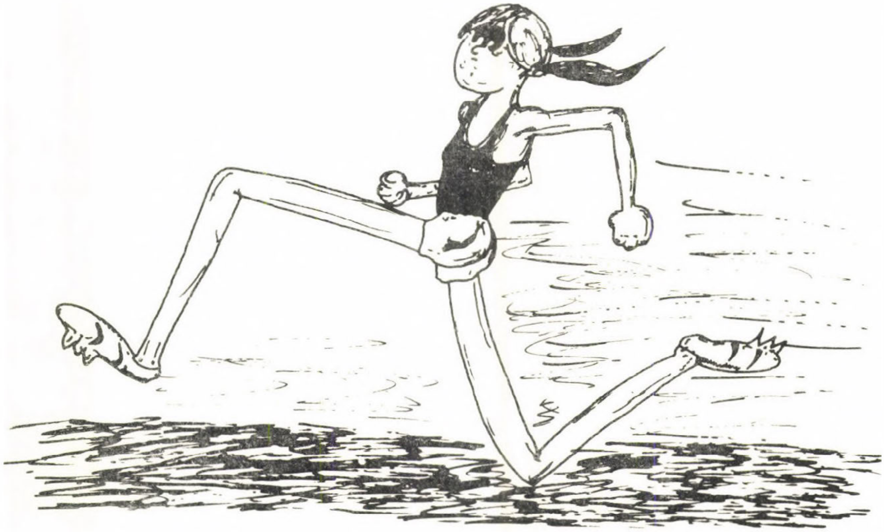
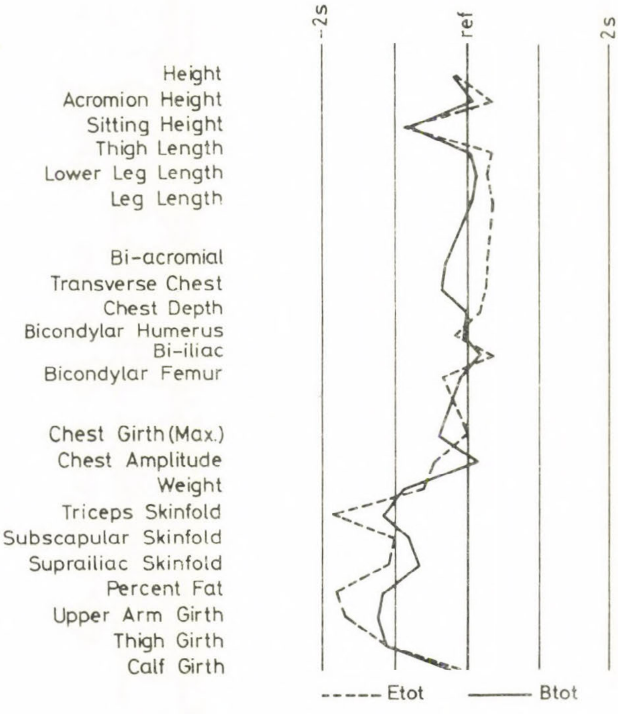


Fig. 1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Bicondylar Femur
Chest Girth (Max.)
Chest Amplitude
Weight
Triceps Skinfold
Subscapular Skinfold
Suprailiac Skinfold
Percent Fat
Upper Arm Girth
Thigh Girth
Calf Girth
----- Etot
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Fig. 2.

PROCEDURES

The runners studied included 33 female distance runners who participated in the European Championships at Rome in 1974 and the 33 most proficient Belgian distance runners of that year. A group of 33 Flemish physical education undergraduates served as a reference group against which the other groups could be compared.

The runners were subdivided into middle distance /800 m/ and long distance groups /1500 and 3000 m/ depending on the event in which their best times had been run.

For each subject 30 measures were taken, from which derived measures, indices, and somatotypes were developed. A total of 52 measures was included in the original analysis.

RESULTS

In Figure 2, profile graphs are presented which allow the comparison of selected physical measures among the European runners /E tot/. the Belgian runners /B tot/, and the reference group of physical education students. The wide line represents the mean scores of the reference group and the narrow lines indicate $\pm$ 1 and 2s.

It can be seen that the mean height of the European runners was almost identical to the reference group, while that of the Belgians was 0.2S below the reference mean. Both groups of runners showed mean acromion heights that were relatively great compared to their standing heights. Thus, the runners had relatively short heads and necks.

For both groups, mean sitting height was more than 0.9S below the reference group. This difference is partly accounted for by the shorter heads and necks but a definite difference in torso length exists between the runners and the reference group. In thigh length, lower leg length, and total leg length, the runners showed proportionally greater mean values than the reference group.

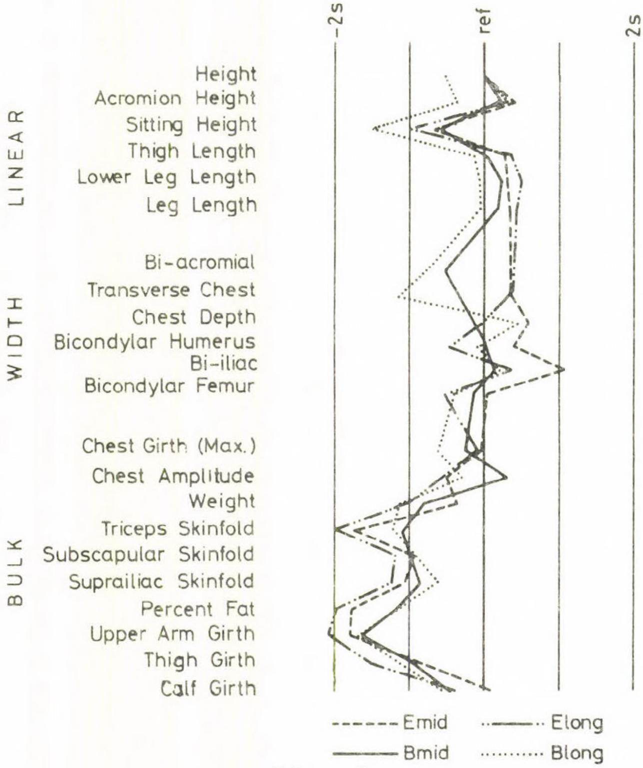
Among the width measures, a lack of any consistant pattern was noted. In bi-iliac diameter both groups of runners exceeded expectations, the European group by nearly 0.6s. In contrast, the mean bone diameter measures of both groups fell below the reference standard, although only those of the European girls indicated proportionally narrow humerus and femur measurements. For the chest and shoulder measures, the European group showed somewhat larger mean scores than the reference group, while the Belgian girls showed proportionally small mean values.

Among the body bulk measures the runners tended strongly toward mean scores below those of the reference group. For body weight both groups were more than 0.8S below the reference mean. For most variables the European group showed more extreme differences than the Belgian group, with some of the skinfold means and percent fat approaching -2S. Exceptions were maximum chest girth and calf girth where the differences from the reference group were less extreme for the Europeans than for the Belgians.

Figure 3 presents a profile graph which allows comparison of the middle distance /E mid, B mid/ and long distance /E long, B long/ runners with each other and with the reference group. It can be seen that only the B long group, at -0.6 s, differed distinctly in height from the reference group. All four groups of runners were proportionally taller at the acromion than the reference group, but they did not differ from each other in this regard.

In sitting height a distinct difference appeared between the middle and long distance runners. The expected mean difference between runners and reference group was far more pronounced among the long distance runners. This difference was echoed in all of the mean lower limb measurements where the expected differences between runners and reference group were more pronounced among the long distance runners.

Among width measures a common pattern was not observed. For femur diameter all four subgroups showed mean scores below the reference group, with the long distance groups farther from the reference standard than the middle distance groups. For humerus diameter the European middle distance group was the only subgroup with a positive mean standard score /s = 0.3/. All four groups exceeded the reference stan-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Bi-iliac
Bicondylar Femur
Chest Girth (Max.)
Chest Amplitude
Weight
Triceps Skinfold
Subscapular Skinfold
Suprailiac Skinfold
Percent Fat
Upper Arm Girth
Thigh Girth
Calf Girth
Emid
Elong
Bmid
Blong

Fig. 3

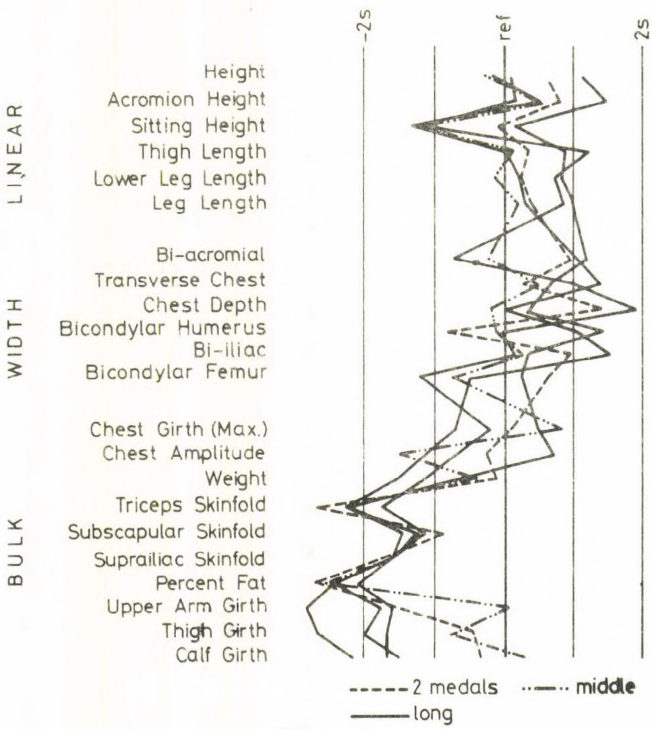
-2s
ref
2s
LINEAR
WIDTH
BULK
Height
Acromion Height
Sitting Height
Thigh Length
Lower Leg Length
Leg Length
Bi-acromial
Transverse Chest
Chest Depth
Bicondylar Humerus
Bi-iliac
Bicondylar Femur
Chest Girth (Max.)
Chest Amplitude
Weight
Triceps Skinfold
Subscapular Skinfold
Suprailiac Skinfold
Percent Fat
Upper Arm Girth
Thigh Girth
Calf Girth
2 medals
middle
long

Fig. 4

dard in bi-iliac diameter, with the E mid group almost 1 S above the reference mean. For the chest diameters and bi-acrominal width the various mean scores tended to contradict each other.

The body bulk measures showed a strong tendency for the mean scores of the European long distance runners to be smaller and therefore more extremely deviant from the reference standard than those of their middle distance counterparts. Of the ten bulk measures, in nine cases the long distance group showed the lower mean scores. Among the Belgian runners this tendency was not supported. Considering the short mean stature of the B long group, mean scores for nine of the bulk measures suggested that the Belgian long distance runners were relatively more bulky than their middle distance counterparts.

Figure 4 presents individual profiles of five runners who won six of the nine medals at the 1974 European Championships. In terms of stature they were a diverse group, whose heights ranged from -0.2 s to 1.1 s when compared to the reference standard. Each of the five showed the short head and neck noted in the mean profiles and four of them showed extreme cases of this phenomenon. They all had relatively short sitting heights and four of them had relatively shorter sitting heights than the mean of the European group. The lower limb measures reflected the mean scores in that the legs were relatively long compared to the reference group. Four of the five emulated the mean data in which thigh length was greater than the reference standard by an amount proportionally larger than lower leg length.

Among the width measures no consistant and useful patterns were observed, although all five girls showed bi-iliac diameters larger than the reference standard and four of them showed transverse chest diameters greater than the reference group mean. For the width measures the medal winners could not be considered as extreme members of the European group.

For most of the body bulk measures the data for the medal winners suggested that they were an unselected sub set of the European group. The exceptions were the three skinfold

Table 1. Somatotype data

Group	N	Mean somatotype	S.A.M.
E tot	33	1.7, 3.4, 3.7	1.04
E mid	13	1.9, 3.9, 3.3	0.86
E long	20	1.6, 3.2, 4.0	0.99
B tot	33	2.3, 3.5, 3.7	0.95
B mid	23	2.3, 3.4, 3.8	0.99
B long	10	2.2, 3.7, 3.4	0.86
Ref	33	3.4, 4.1, 3.0	1.22

Table 2. S.A.D.s among mean somatotypes

	E mid	E long	B tot	B mid	B long	Ref
E tot	0.61	0.40	0.53	0.57	0.62	1.97
E mid		1.01	0.59	0.73	0.33	1.58
E long			0.79	0.73	0.98	2.27
B tot				0.14	0.33	1.48
B mid					0.47	1.56
B long						1.37

measures and percent fat which indicated that these five subjects were leaner than the mean of this very lean group.

Somatotypes were assessed using the technique of Heath and Carter /1972/. The somatotype data are presented in Table 1. The mean somatotype for the reference group /3.4, 4.1, 3.0/ was symmetric and moderately athletic, with a mean of 4.1 for mesomorphy. This mean somatotype is not unexpected in a group of female physical education students. The Belgian runners /2.3, 3.5, 3.7/ showed less mesomorphy, less endomorphy and more ectomorphy than the reference group. The mean somatotype of the European group /1.7, 3.4, 3.7/ showed less endomorphy than the Belgians but was nearly identical in the other components. The group showing the least mean endomorphy /1.6/ was the European long distance runners.

The last column of Table 1 shows the Somatotype Attitudinal Mean /S.A.M./ for each group and subgroup. Each S.A.M. is the mean of the Somatotype Attitudinal Distances /S.A.D./ of the individual somatotypes in the group from the group mean /Duquet, 1976/. The S.A.M. is therefore an index of relative looseness of cluster of a number of points around their mean. Among these data the reference group showed the largest S.A.M. of 1.22, not unexpected considering the relatively unselected nature of the group.

The European group had a S.A.M. of 1.04. This value was larger than the S.A.M.s for the two European subgroups. Thus, the European middle and long distance runners tended to be

---

Duquet's techniques are founded on a three dimensional concept of somatotype, in which any three digit somatotype can be located exactly at a unique point in the matrix. The distance between any two somatotypes /points in the matrix/ can be ascertained by geometry. The formulas are:

$$\text{S.A.D.} = \sqrt{\Delta_{I}^{2} + \Delta_{II}^{2} + \Delta_{III}^{2}}$$

where Δ_I = difference between first component /endomorphy/ values of the somatotypes being compared. Δ_{II} = mesomorphy difference. Δ_{III} = ectomorphy difference.

$$\text{S.A.M.} = \frac{\sum \text{S. A. D.}}{N}$$

somatotypically different groups although some overlap did occur.

The S.A.M.s for the Belgian runners did not show a similar pattern, since the S.A.M. for the middle distance runners /0.99/ was larger than for the total group /0.95/. Thus, no tendency seems to exist for the Belgian subgroups to be somatotypically distinct from each other.

Figure 5 presents a standard somatochart on which the mean somatotypes of groups and subgroups are platted. Despite the fact that this is a two dimensional technique for illustrating a three dimensional concept, some salient points can be noted. All of the mean somatoplots of the runners were relatively bunched and in a different area of the chart from the mean of the reference group. The European runners deviated more extremely from the reference group than did the Belgian runners. The European middle distance subgroup were clearly the most mesomorphic of the runners, while the European long distance runners were the most ectomorphic.

Table 2 presents the S.A.D.s among all the mean somatotypes of the three groups and four subgroups. All the values in the right column are larger than any others in the matrix. This clarifies further that all of the runners' groups were more deviant from the reference group than they were from each other.

The S.A.D between the European middle and long distance runners was 1.01 and between the Belgian subgroups the S.A.D. was less than half, or 0.47. These data support the earlier statement that the European middle and long distance groups tended to be separate somatotypically, while the Belgian subgroups did not.

DISCUSSIONS AND CONCLUSIONS

This study was developed upon a three part hypothesis which will guide the discussion to follow:

/1/ Successful female distance runners will show physique characteristics different from those of unselected athletic females. Figure 2 establishes that, on the average, linear proportions of distance runners differ from the reference standard. The runners have proportionally broad bi-iliac diameters. They tend toward narrow humerus and femur diameters, although the Belgian runners did not show this characteristic. In all of the body bulk measures, including weight, girths, skinfolds, and percent fat, the runners mean data indicated that they were a different group from the reference group. The mean data were confirmed /Figure 4/ in almost every case by the five medal winners. Based on the subjects of this study, the following elements are valid components of the physical stereotype of the female distance runner: average standing height, proportionally short head, neck and torso, proportionally long lower limbs with thigh length more pronounced than lower leg length, broad hips, slender long bones, small girths, small skinfolds, low body weight, and low percent fat.

In somatotype, the runners' mean values clustered in an area of the somatochart distinctly away from the mean of the reference group /Figure 5/. The runners were generally less endomorphic, less mesomorphic and more ectomorphic than the reference group /Table 1/. The S.A.M.s /Table 1/ and the S.A.D.s among the group means /Table 2/ were such that all but a small fraction of the 99 subjects could be classified as "runner" or "reference group" by calculating the appropriate S.A.D.s.

/2/ These differences will be more pronounced among more proficient than less proficient runners. As a group the European runners were more proficient than the Belgians. In Figure 2 the mean profiles indicate that, of the items making up the stereotype described above, the Europeans varied more extremely from the reference standard than the Belgians in almost all cases. The five medal winners, the most proficient runners in the study, showed "hyper-extreme" scores in the following: head and neck length, torso length, lower limb length, skinfolds and percent fat.

In somatotype, the Europeans showed mean values more widely separated from the reference group than the Belgians /Figure 5, Table 2/.

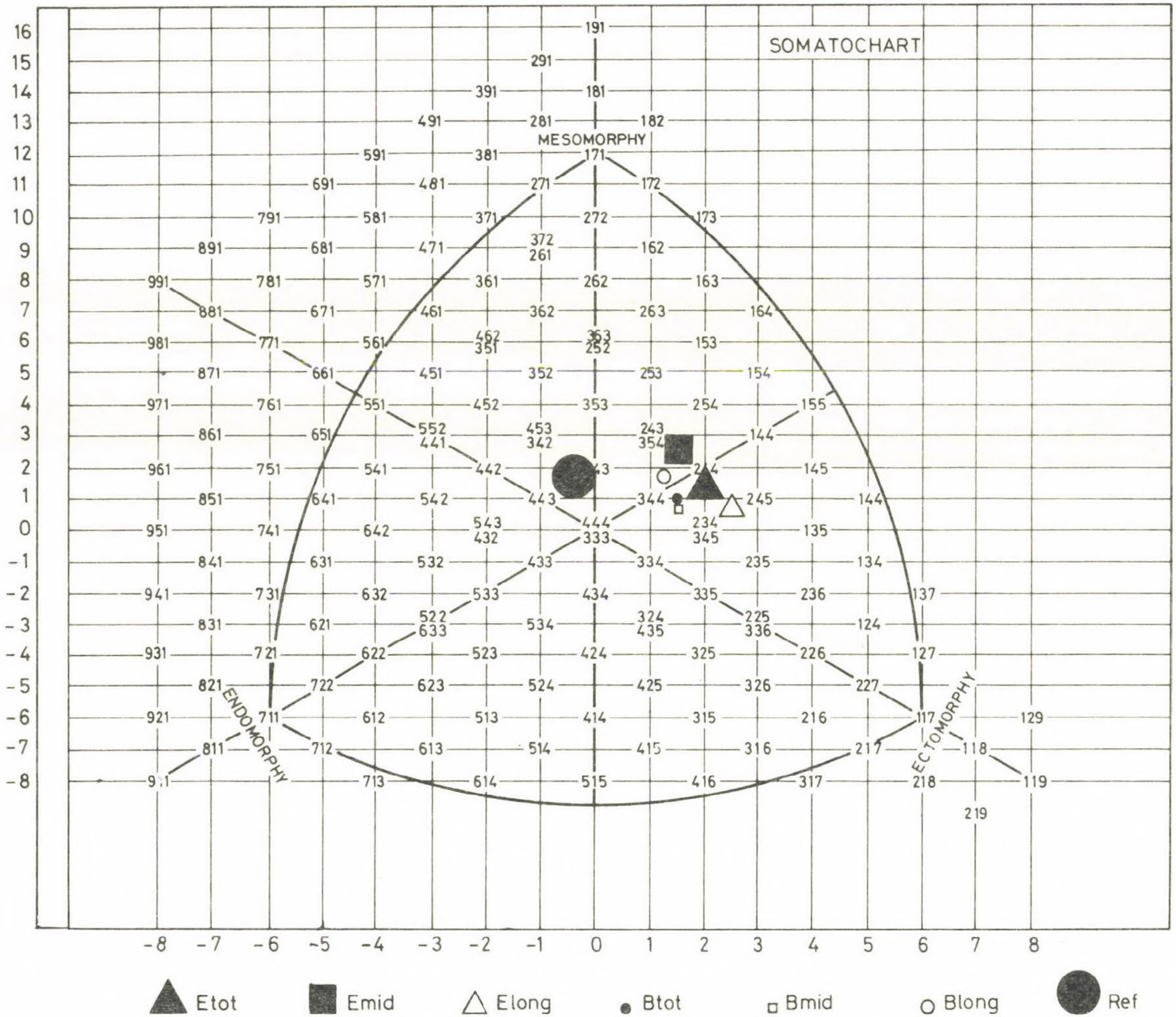
SOMATOCHART
MESOMORPHY
ENDOMORPHY
ECTOMORPHY
Etot
Emid
Elong
Btot
Bmid
Blong
Ref

Fig. 5

The total effect of these statistics is support for the position that, on the average, more proficient distance runners exhibit more extreme examples of the distance runners physique. /3/ These differences will be more pronounced among long distance than among middle distance runners. The profile in Figure 3 makesit clear that long distance and middle distance runners have different characteristies, when considered on a group basis. The European long distance group showed, more extreme linear disproportions and lower body bulk scores than the European middle distance group. The Belgian long distance group also demonstrated greater linear disproportion than their middle distance counterparts but were not distinctly different in the bulk measures.

Considering mean somatotypes /Figure 5, Table 2/ it can be noted that the mean of the European long distance group is the most greatly removed from the mean of the reference group /S.A.D. = 2.27/. Paradoxically it must be reported that the Belgian long distance group is the least removed /S.A.D. = = 1.37/ of all the subgroups.

It would be convenient, and perhaps even defensible, to ignore the Belgian data at this pointand accept the clear-cut European anthropometric and somatotype data in support of the hypothesis. The fact that the Belgian data partly support and partly refute the hypothesis may not be important since the Belgian girls are a less highly selected and less proficient group than the Europeans.

This last hypothesis may need more study to ascertain if it can indeed be applied to female runners at all proficiency levels.

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Growth and Development; Physique *Symp. Biol. Hung. 20, (1977)*

EARLY AND LATE MATURITY IN BELGIAN BOYS, 6 TO 13 YEARS OF AGE AND ITS RELATION TO BODY TYPE

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Free University Brussels, Brussels, Belgium

ABSTRACT

From more than 3000 Belgian boys 6 to 13 years of age, skeletal age (Greulich-Pyle) as main criterion of maturity and somatotype (Heath-Carter) as physique indicator, were determined and related with each other. For each age group, the subjects were divided into early, average and late maturing groups, which were then compared for differences in endo-, meso- and ectomorphy, by means of ANOVA tests. The somatotypes of each group were also plotted onto somatocharts and examined for significant localisation.
The results have shown that early and late maturing boys can generally be classified in the same somatotype region. From the age of ten on however, there seems to be a slight tendency for early maturers to show a more mesomorphic endomorphy dominance, whereas the late maturers show more of a tendency toward ectomorphic mesomorphy.

INTRODUCTION

A number of investigators have presented some evidence suggesting that relative fatness is associated with early maturation (Dupertuis and Michael 1953 ; Hunt, Cock and Gallagher 1958 ; Clarke, Irving and Heath 1961, Livson and Mc Neill 1962 ; Hortling, De la Chapelle, Frisk and Widholm 1964 ; De Wijn 1965 ; Frisk, Widholm, Tenhunen and Hortling 1966 ; Acheson and Dupertuis 1967 ; Beunen 1973).
In an earlier study (Borms, Hebbelinck and Ross 1973) on early and late mature boys, our findings were in agreement with the results reported in these studies. However, this earlier analysis was carried out but on twelve year old boys, who were subjects from a much larger sample of six to thir-

teen year old children.
The focus of the present study is on the investigation of the relationship between somatotype and skeletal maturity in primary school boys from the age of six on, who were enrolled in schools selected at random from a list of all the Belgian schools in a comprehensive national "Performance and Talent Project" (Hebbelinck and Cliquet, 1970) [1].

METHODS

Skeletal age was determined by ratings of X-rays of the left hand and wrist of the subjects using the Greulich-Pyle method (1959). Heath-Carter (1967) somatotypes were obtained anthropometrically using height, weight and skinfolds at triceps, subscapular and suprailiac sites ,knee width and arm girth. The two missing variables, elbow width and skinfold calf, were substituted for by a regression equation. Skeletal age/chronological age ratios were calculated for each subject. Based upon the upper, middle and lower 20 percentage groups on the maturation ratio pércentile scale, three groups were formed : an early, and average and a late maturing group. The average maturing group was used for comparative reasons.
Normality (chi-square) and homoscedasticity (Sokal and Rohlf, 1969) of the data in each group were checked. The Duncan New Multiple Range Test for multiple comparisons among the means based on unequal sample sizes was used for the analyses of variance in the present study testing the null hypothesis of equality of means (Duncan 1957). In many instances where the requirements for a parametrical test could not be met nonparametrical ANOVA tests such as Kruskall-Wallis and Dwass were applied (Sokal and Rohlf 1969). Pearson product moment and Spearman rank correlations were calculated between skeletal age and each of the three somatotype components.
All the subjects thus identified, having complete data were plotted on Heath-Carter somatocharts by a procedure outlined by Hebbelinck and Ross (1973).

[1] ACKNOWLEDGMENT
This study is part of the research project "Performance and Talent". This investigation is supported by the Belgian Ministry of Education and Culture (BLOSO & ADEPS), the Ministry of Health & Family (CBGS), and the Belgian Fund for Fundamental Collective Research (FKFO) under contract nr. 935.

RESULTS

From six to nine years of age, none of the correlation coefficients were significantly different from zero. From ages 10 to 12 the correlational analysis of separate somatotype components also revealed low coefficients (table 1). Only at ages ten, eleven and twelve the correlations between skeletal age and endomorphy were statistically significant ($p \leqslant .01$). Only at age twelve a significant ($p \leqslant .01$), but low correlation was produced between skeletal age and ectomorphy.

The results of the ANOVA's are presented in table 2. The underscoring by a common line of any two groups indicates that the groups do not differ significantly. Any two or three groups not underscored by the same line do differ significantly. The one percent probability level was selected.

Table 1 Correlation coefficients between skeletal age and somatotype components

Age groups	(N)	Endomorphy	Mesomorphy	Ectomorphy
10	(108)	.247 *	-.132	.069
11	(225)	.303 *	.003	-.050
12	(356)	.316 *	.111	-.190 *
13	(380)	.206	.210	-.265

* $p \leqslant .01$

Except at age 10, the late maturers (L) had the lowest endomorphic rating, while the early maturers (E) had the highest endomorphy at all ages ; the differences, however, were never significant except at ages eleven and twelve where the difference in endomorphy between early and late maturing boys was more than 1 unit.

For mesomorphy none of the groups were significantly differing from each other at each of the different age levels. A similar result was obtained for ectomorphy.

Another critical test that might reveal any relationship between maturity and physique, was carried out. Since essentially the basic concept of a somatotype requires to study a type as a "Gestallt", each subject's somatotype was plotted onto somatocharts and classified according to the relative dominance in the complete type. The thirteen areas of the somato-

Table 2 Analysis of differences between early, average and late maturity groups for endo-, meso-, and ectomorphy.

Age		Endomorphy			Mesomorphy			Ectomorphy		
6		L	A	E	A	L	E	L	E	A
	$\overline{X}$	1.13	1.36	2.6	4.27	4.53	4.67	1.76	2.04	2.07
	s	.01	.43	7.81	.77	.73	1.29	.65	1.21	1.30
		H=.34			F=.32			F=.17		
7		L	A	E	A	L	E	E	L	A
	$\overline{X}$	1.32	1.52	1.85	3.99	4.10	4.30	2.49	2.50	2.66
	s	.82	1.02	1.12	.61	.81	.80	.69	.86	1.08
		F=1.29			F=.80			F=.21		
8		L	A	E	L	A	E	E	L	A
	$\overline{X}$	1.44	1.39	1.82	3.67	3.74	4.03	2.61	2.95	2.83
	s	.50	.77	1.95	.65	.64	.96	1.18	.84	.93
		H=1.18			F=1.17			F=.55		
9		L	A	E	L	E	A	A	L	E
	$\overline{X}$	1.64	1.88	2.19	3.61	3.80	3.86	2.96	3.15	3.19
	s	1.31	2.85	3.12	.73	1.26	.75	1.08	.96	1.28
		H=1.95			F=.35			F=.23		
10		A	L	E	E	L	A	E	L	A
	$\overline{X}$	1.26	1.44	2.16	3.45	3.55	3.63	3.17	3.28	3.51
	s	.35	.49	3.11	.97	.84	.71	1.39	1.06	.78
		H=5.47			F=.25			F=.54		
11		L	A	E	L	A	E	E	A	L
	$\overline{X}$	1.27	2.08	2.64	3.13	3.26	3.31	3.28	3.46	3.61
	s	.55	2.33	3.64	.33	.87	.72	1.83	1.59	.48
		H=18.44 *			H=.88			H=.87		
12		L	A	E	L	A	E	E	A	L
	$\overline{X}$	1.41	1.64	2.68	3.32	3.32	3.49	3.23	3.63	3.65
	s	.54	1.33	3.19	.67	.77	.98	1.59	.97	.79
		H=26.49 *			H=1.14			H=4.34		
13		L	A	E	A	E	L	E	L	A
	$\overline{X}$	1.64	1.64	2.00	3.16	3.34	3.41	3.31	3.49	3.82
	s	1.07	1.14	2.06	.98	1.06	1.00	1.26	1.10	.85
		H=.43			F=.23			F=.83		

Legend : H=critical ratio for Kruskall-Wallis test ; F=critical ratio for Duncan New Multiple Range Test; * =$p \leq .01$; L=20 percent skeletally most retarded boys ; A=20 percent skeletally average boys ; E=20 percent skeletally most advanced boys ; $\overline{X}$= mean ; s= standard deviation.

chart, proposed by Carter (1972) were considered an appropriate way for classification. A combination of each of these regions yielded following three gross somatotype categories :

category 1 : mesomorphic endomorph
balanced endomorph
ectomorphic endomorph

category 2 : ectomorphic mesomorph
balanced mesomorph
endomorphic mesomorph

category 3 : endomorphic ectomorph
balanced ectomorph
mesomorphic ectomorph

The remaining types, such as endo-ecto, meso-endo, ecto-meso and central types were poorly represented and disregarded from the analysis.

Fig. 1 shows the results of the plotting procedure for each age category. Although there was a clear tendency toward a higher endomorphic rating in the early maturers, the computed chi-squares failed to reach the required level of significance (X^2=6.63) to show a significant difference between the somatoplots.

Generally, there seemed to be a localisation in both the ectomorphic mesomorphy and the mesomorphic ectomorphy area. From age 6 to 13 on there was a trend for a shift from the ectomorphic mesomorphy area towards the mesomorphic ectomorphic area (cf. Duquet, Hebbelinck, Borms 1976). In conclusion, skeletally advanced and retarded children do not differ in body type untill the age of eleven years. From the age of eleven on, it can be seen that in the skeletally advanced group (the filled circles on fig. 1) there is a tendency to have more endomorphic boys.

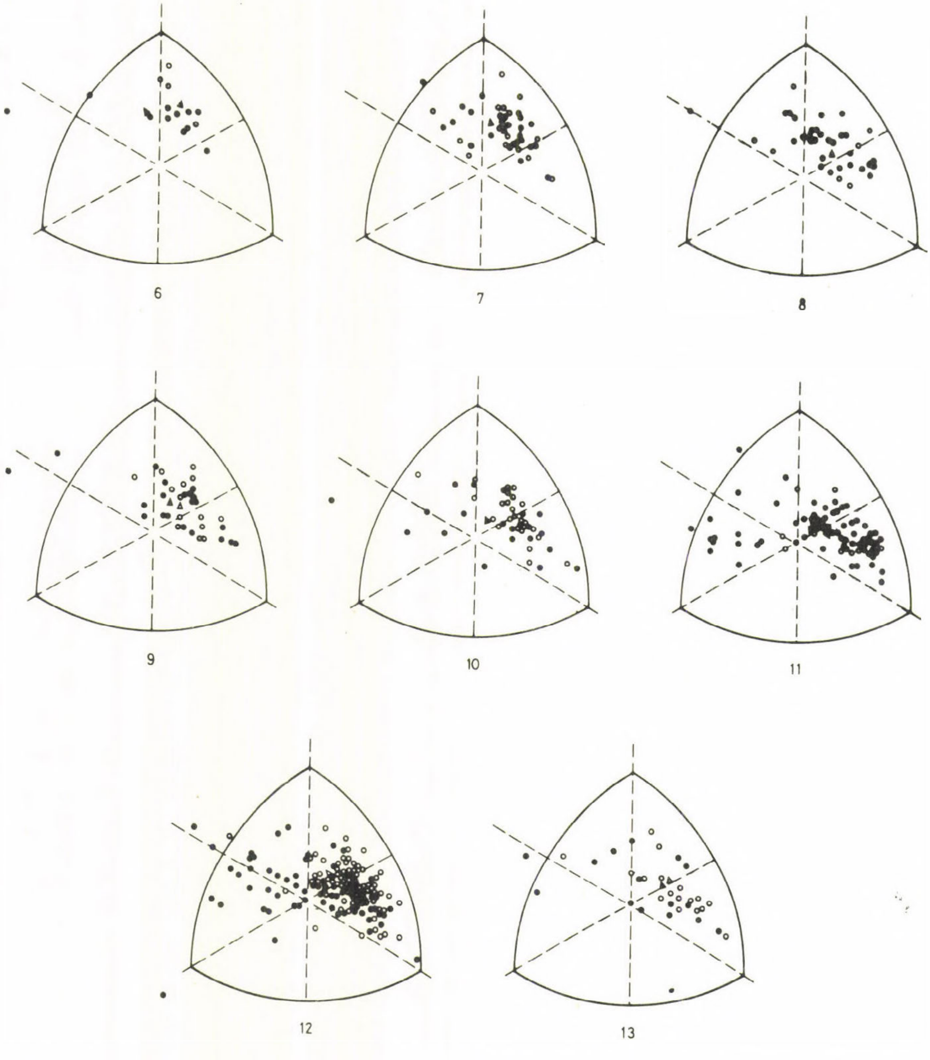

Fig. 1 Somatotype distribution of skeletally advanced (●) and skeletall. retarded (O) boys of 6 to 13 years of age.
No chi-square value reached the .01 significance level. ▲ = mean of the skeletally advanced group ; △ = mean of the skeletally retarded group.

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PHYSIQUE AND GROWTH ESTIMATED BY CONRAD'S AND HEATH-CARTER'S SOMATOCHARTS IN ATHLETIC CHILDREN

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Abstract

In about 14oo athletic children, who were between 6 and 16 years of age and attended regular training in one of the altogether 15 branches of sports in the Central School of Sports, 6 to 45 body dimensions were measured. In a subgroup of 7o children a longitudinal 2-years study evidenced the principal trends of growth under the conditions of regular and programmed training. In assessing certain traits of the developing physique Conrad's metric and plastic index system and Heath-Carter's three-component somatotyping method were employed. Conrad's somatochart was slightly modified so as to include also child dimensions, regression equations were fitted to help computer processing of data, and coordinates were re-scaled to ease the application of basic statistics to the somatoplots. To the same ends, Ross and Wilson's suggestion of coordinate transformation was adopted in plotting somatotypes in the Heath-Carter somatochart. As compared on the material, the two somatotyping methods are largely independent from one another, and when applied in combination, they yield a better view of the developing physique.

Introduction

In Hungary the schools of sports work either under the management of the clubs or they are organized on a territorial basis. Both kinds vary in regard of the events they train. Irrespective, however, of their management, they have a common schedule of conditioning and training. The children attend ordinary schools and come only for training to these sports schools. Entrance age is 10 years for most disciplines, 6 to 8 for gymnasts and swimmers, and 12 for the combative sports. The weekly number of training sessions varies from 3 to 12, depending on age and event. The curricula of the sports schools ensure a variegated general foundation of basic motor skills and athletic abilities on which the technicalities of the events can be securely laid.

To follow up the development of these athletic youngsters until they arrive at the top of their preferred event was a natural urge. In the present paper covering the first two years after entrance, i.e. the general conditioning period, data of a broader cross-sectional study /CS/ were compared to a two-years longitudinal study /LS/, on the one hand and on the other hand, possible differences of the constitutional traits depending on event preference were studied by two methods of phenotyping.

Material and Methods

In the CS body dimensions and indices were obtained from about 1400 children of both sexes and between 5 and 17 years of age. 15 events of sports were involved. In the LS 70 children were followed up for two consecutive years: 9 girls and 2 boys in basketball, 5 girl gymnasts, 2 paddler boys, 11 modern pentathlonists, 6 girls and 3 boys in table-tennis, 13 girls and 12 boys in track and field, and 8 waterpolo players. Their age ranges are indicated in the figures.

Body dimensions were taken according to Martin and Saller's /1959/ and the IBP suggestions /Weiner and Lourie 1969/, metric /MEX/ and plastic /PLX/ indices of Conrad's phenotyping method /1963/ by using equations fitted to the original nomographic and tabular data, but scaling was transformed and the somatochart was extended to include also children /Fig. 1/. Ratings for the three Heath-Carter /H-C/ components were based on Eqs. /1/-/3/ derived from the tables of Hebbelinck et al. /1972/:

$$ENDO = 0.79LN^2/SSF/ - 2.11LN/SSF/ + 1.18 \qquad /1/$$

$$MESO = 0.86BHUM + 0.60BFEM + 0.19/AGFL - 0.1TRSF/ + \\ + 0.16/CALG - 0.1MCSF/ - 0.13BOHT + 4.50 \qquad /2/$$

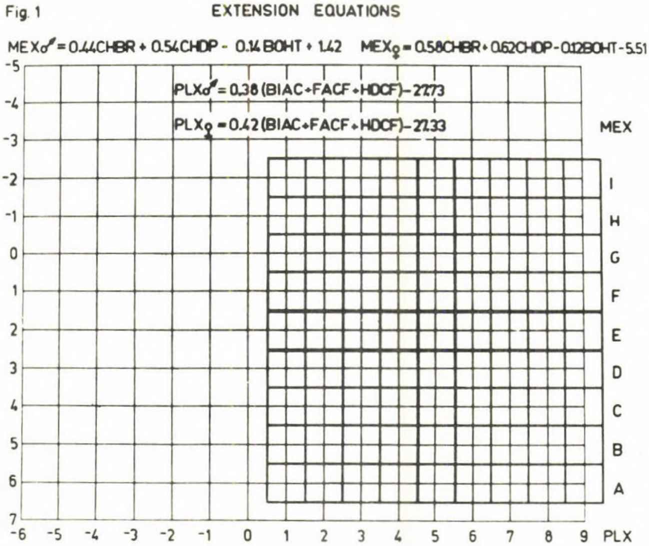

Fig. 1. Extended and re-scaled Conrad somatoplot for use in children. Ordinate: metric index /MEX/, abscissa: plastic index /PLX/. Codes in the equations of sex-dependent indices: CHBR = mesosternal chest breadth; CHDP = chest depth; BIAC = shoulder width; FACF = forearm girth; HDCF = hand circumference, BOHT = stature; all dimensions in cm.

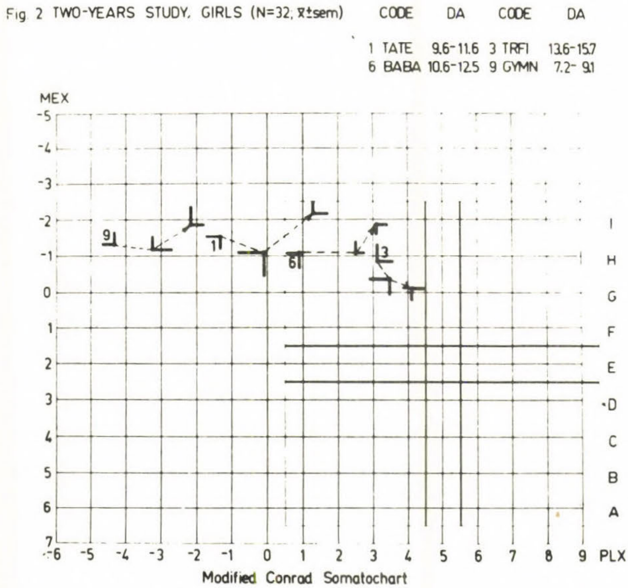

Fig. 2. Conrad plots of girls /LS/. Event codes: BABA = basketball; GYMN = gymnastics; TATE = table-tennis; TRFI = track and field; DA = decimal age range /yr/ covered by the study. Heavy lines: s.e.m.; dashed lines: path of development, arrows at end status.

$$ECTO = 0.73BOHT/BOWT^{-0.333}/ - 27.58, \qquad /3/$$

where LN:natural logarithm; SSF:sum of triceps, scapular and iliac skinfolds; BHUM:biepicondylar humerus width; BFEM: biepicondylar femur width; AGFL:flexed arm girth; TRSF:triceps skinfold; CALG:calf girth; MCSF:medial calf skinfold; BOHT: stature; and BOWT:body weight.

H-C scales were transformed:

$$X = ECTO - ENDO \qquad /4/$$

$$Y = 2MESO - ECTO - ENDO, \qquad /5/$$

and ENDO was corrected for statures below 170.18 by

$$C = 170.18/BOHT \qquad /Ross\ et\ al.\ 1974/. \qquad /6/$$

For variability estimates bidimensional dispersion was used also in the H-C plots since experience had shown most small group plots to differ from the circular /Ross et al. 1974; Fig. 4/

Results

CS data and indices are presented in Table 1. In girls metroleptomorphy was almost constant until 13 years of age. In boys there was a slight decrease in MEX between 5 and 11. Also the plateau was more metromorphic than in girls, but this was due to the difference of the male rating procedure. PLX moved one unit per year on the average in both sexes, and MEX increased more or less sharply after puberty.

H-C plots of the girls in the CS resided almost wholly in the central hexagon, decreasing slightly in mesomorphy while those of the boys showed an upward concave curve in the ecto-mesomorphic region with a slight increase in mesomorphy with advancing age. Dispersion was here marked for both sexes.

LS plots /Figs. 2 and 3 for Conrad, 5 and 6 for H-C/ conformed in general to those in the CS. However, some trends were different: variability in MEX was larger in boys; girl gymnasts progressed faster in PLX and separated clearly in mesomorphy; female basketball players underwent a belated and marked increase in leptomorphy which, however, corresponded to a proportional rise of height and weight as reflected by the stability of their H-C plot. Waterpolo players segregated clearly from the rest in both somatoplots: they were robust, fat and metromorph in comparison to their age mates.

Table 1. Indices of physique in children of 5 to 17 /CS study/

SEX	AGE RANGE	N		DEC. AGE	CONRAD MEX	CONRAD PLX	HEATH-CARTER X	HEATH-CARTER Y
BOYS	05-08	66	x̄	7.22	-0.47	-4.34	0.46	2.88
			sd	0.63	1.37	1.57	2.02	2.31
	08-09	71	x̄	8.57	-0.42	-3.68	0.58	2.58
			sd	0.28	0.97	1.66	2.38	1.88
	09-10	103	x̄	9.58	-0.69	-2.59	0.68	2.52
			sd	0.28	1.06	1.57	2.76	2.51
	10-11	184	x̄	10.49	-1.08	-1.95	0.63	2.06
			sd	0.28	1.05	1.62	2.75	2.09
	11-12	142	x̄	11.46	-1.43	-0.93	0.72	1.58
			sd	0.28	0.99	1.50	2.44	2.24
	12-13	118	x̄	12.42	-1.49	0.12	0.95	1.48
			sd	0.25	1.01	1.72	2.34	2.32
	13-14	72	x̄	13.56	-1.43	2.02	1.49	0.66
			sd	0.23	1.22	1.81	2.75	2.60
	14-15	58	x̄	14.53	-0.74	2.53	2.17	1.65
			sd	0.36	1.84	1.72	1.96	2.47
	15-17	38	x̄	15.81	-0.34	4.84	2.37	2.03
			sd	0.60	1.83	1.35	0.89	3.60
GIRLS	05-08	49	x̄	6.97	-1.77	-3.68	0.08	1.73
			sd	0.69	0.60	1.19	1.67	1.78
	08-09	49	x̄	8.47	-1.59	-1.83	-0.44	0.55
			sd	0.29	0.91	1.17	2.48	2.00
	09-10	56	x̄	9.58	-1.80	-0.76	0.26	0.63
			sd	0.31	1.03	1.08	2.57	2.19
	10-11	135	x̄	10.54	-1.57	0.18	0.03	0.48
			sd	0.26	1.25	1.50	2.55	2.11
	11-12	76	x̄	11.40	-1.76	1.16	0.52	-0.10
			sd	0.33	1.29	1.47	2.05	1.87
	12-13	75	x̄	12.41	-1.87	2.08	0.89	-0.76
			sd	0.26	1.46	1.61	2.41	2.73
	13-14	56	x̄	13.45	-0.63	2.34	0.67	-0.61
			sd	0.29	1.19	1.97	2.22	2.96
	14-15	48	x̄	14.47	0.22	3.06	0.84	-0.30
			sd	0.30	1.77	2.18	1.76	3.51
	15-17	30	x̄	15.88	0.23	3.82	0.65	-1.82
			sd	0.58	1.50	0.70	1.48	1.98

Bidimensional variation showed not too great changes in the Conrad plots, but considerable ones in the H-C plots /LS/.

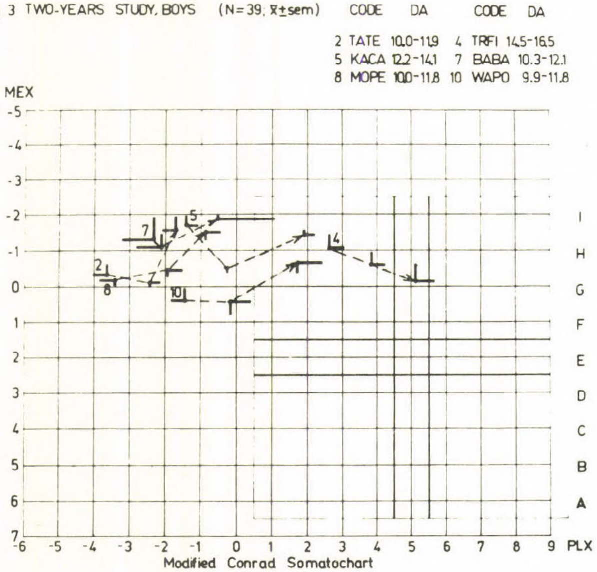

Fig. 3. Conrad plots of boys /LS/. Event codes: KACA = kayak - canoe; MOPE = modern pentathlon; WAPO = waterpolo. Other codes and signs as in Fig. 2.

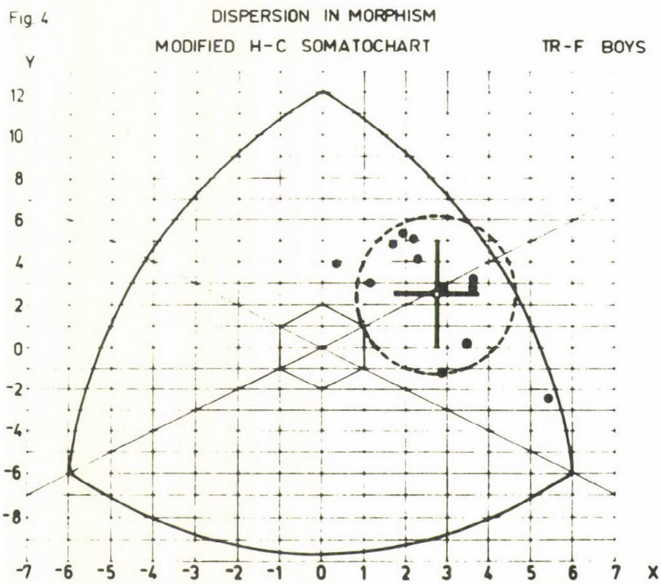

Fig. 4. Example to explain preference for bidimensional dispersion estimates /sd: heavy line/ vs. circular ones /dispersion distance sd, Ross et al. 1974: dashed circle/ of non-circular small samples. Inequal arms of variation indicate greater dispersion of Y than X. X = ECTO - ENDO; Y = 2 MESO - - ECTO - ENDO.

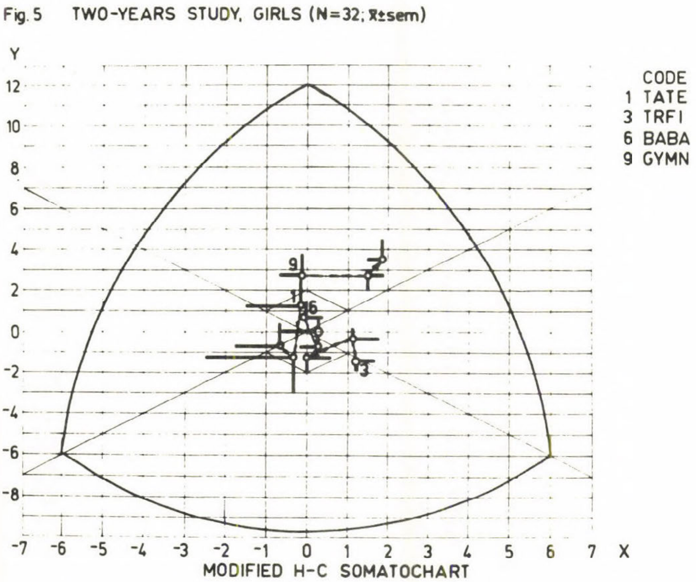

Fig. 5. Heath-Carter plots of girls /LS/. Codes and signs as in Figs. 2 and 4.

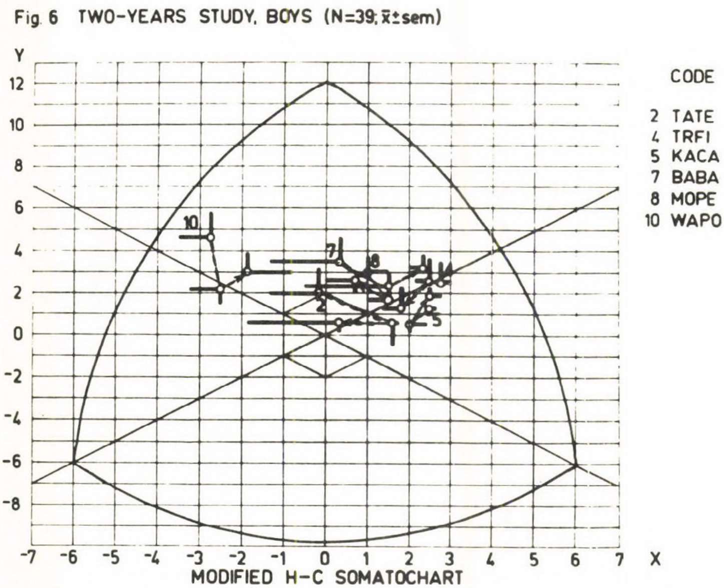

Fig. 6. Heath-Carter plots of boys /LS/. Codes and signs as in Figs. 3 and 4.

Discussion

Most of the CS plots were obtained in children who had entered programmed training not much before this study began. Forthcoming observations will settle whether the observed trends keep true also in those participating in training for a longer period. Since except track subjects the LS data refer to beginners, certain agreement was naturally expected. It was interesting to note, however, that there were some discipline-dependent separations too. Most of these may be attributed to the preference of the coaches responsible for the selection of these children for the respective events and physical traits.

Another observation of interest was that despite the widely recognized stability in individual growth trends some of the groups showed dissimilar progress in PLX, covering in one year nearly or more than two units /gymnasts, e.g./. This is suggestive of not only a factor of selection /though this can hardly be denied/, but also of certain specific effects of the event practised. Although, as stated before, all children were engaged in general conditioning work, this conditioning was carried out by using the special means and practices of the event concerned, thus exerting certain influence on the developing physique. This appears to be particularly true in the case of gymnasts and waterpolo players.

On the other hand, as shown by the changing bidimensional dispersion estimates in the H-C charts, individual variability in the components of physique was considerable, precluding hasty predictions about the main trends of individual body composition under a certain regime of training.

To sum up, CS and LS trends of the beginners were found to be acceptably close, but one has to pay due regard to the special events, both in respect of the training methods used and the coaches' preference for certain physical traits of the candidates.

If used in combination, the employed phenotyping methods may offer a more complete picture in addition to their ease, simplicity and acceptable objectivity in describing the rather complex entity of developing physique.

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RECENT DATA TO THE ANALYSIS OF THE VARIATIONS OF PHYSIQUE

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ABSTRACTS

By combined application of the methods elaborated for examinig the variations of physique /somatometry, somatoscopy, somatotyping, factor analysis/, authors analyzed their sample consisting of the most outstanding female track and field athletes of Europe, European female table tennis players, Hungarian female fencers, basket ball and volley ball players as well as two groups of Hungarian female students. To avoid dependence either on the choice of the units of measurements or on the starting point of the system of the measures as far as the quantitative result of their investigation is concerned, the body measurements of the entire sample were submitted to regular standardization. Thus all the determined values of the several body measures became the variates of the expected values of "0" and of the standard deviation of "1". The whole sample was elaborated by applying the method of the generalized-component-analysis. Four generalized measures/factors have been found by the help of which, the physique of the individuals/subgroups of the investigated sample are well characterizable. These factors are MAGNITUDO /Magnitude/, PROCERITAS /Procerity/, FIRMITAS /Firmity/ and INGENIUM MULIERIUM /Femineity/. Results may be interpreted independent of the used mathematic apparatus.

INTRODUCTION

It is a well known fact that factor analysis is a very appropriate tool in the investigation of communalities existing among the individuals of a given population and the individual characteristics selecting the individuum into various groups. The development of computer technique now makes it possible to analyze almost any optionally large masses thereby revealing many new and interesting interrelationships or group-forming characteristics.

In the case of a small number of elements the derived conclusions on the basis of obtained factor analysis apply only to those individual which originally were drawn into the investigation, since increasing the data-base with new individua fundamentally change factor analysis itself. The situation is quite different if the element number of data-base is comparatively large. In such cases we are permitted to disregard factor analysis when investigating a new individuum, but accepting standard factors deriving from calculated factors based on large data-base, thus with these we make the determination of the ranging characteristics of the new individuum. /Obviously conclusions derived thus apply only to individua deriving from such populations for which the data-base can be taken as representative sample./ When the number of examined individuals is large enough then these may be worth while checking against the data-base thereby from time to time we may correct the standard factors.

MATERIAL AND METHOD

In building up our data-base in the beginning quite frequently we had to perform factor analysis because new subgroups were drawn within the sphere of our examination /the most outstanding female track and field athletes of Europe, the most outstanding European female table tennis players, Hungarian female fencers, basket ball and volley ball players, two groups of Hungarian female students as well as fertile women/.

Our present data-base /N = 733/ display a striking stability in case of attaching new individuals to it. Furthermore, grouping the individuals according to factor coefficients they well correspond with the examined subgroups.

This circumstance suggests us that when new individuals are examined - knowing the standard factors - the grouping characteristic be done in situ. The importance of such a performance is at once readily comprehended if we refer to various branches of science: medicine /clinical, sport medicine, etc./, physical education /secondary selection for sports/, applied anthropology /confection industry for clothing, car desings, etc./.

If we take the series of the examined data basis as the linear combination of standard factors /thus e.g. any series of the data matrix is approximated as a few, paired orthogonal vector's linear combination/, then any unknown coefficients - belonging to even recently examined individuals - may be determined by the scalar product of the vectors /e.g. in pocket computer, too/.

If the examination aims at such a group ranging where the relevant group-forming data are reflected in the coefficients referring to the first two factors then the group ranging may be plotted in a two--dimensional diagramme. This two-dimensional diagramme in the case of athletes is however sufficient only to a certain extent. Since we found that the first two factors contain several communalities. Thus, sufficient separation is yielded by the coefficients referring to the first principal components. But because a four-dimensional diagramme may not be plotted, we constructed such a movable nomogramme whose analogue input is the coefficients referring to the first four principal components, and its logical output shows to which group/s/ the examined individuals belong.

RESULTS AND DISCUSSION

Four generalized measures were found by the help of which, the body measurements of the individuals of the examined sample could be characterized with extreme accuracy. To these measures such descriptive content could be attributed too - especially on the basis of certain group-classificative properties - which had not originally involved in the examinations. None of these four measures are identical to either of the well known body measurements, but they are the relatively simple linear functions of them.

Each of the presented formulas are based on 28 variants /on 28 body measurements/. There are neither theoretical, nor practical obstacles in computing these formulae from fewer or more measurements, naturally, the application of more variants would give a higher degree of accuracy, but less of them, would give results of just sufficient exactness.

All of the body measurements used in the study are discrete monotonic characteristics, and subjects can therefore easily be arranged or ordered. It is understandable, that in our first /and most important/ formula each of the body measurements figure with positive co-efficients /Table 1/.

Table 1

Factor 1: MAGNITUDO/MAGNITUDE

Weight	24.1375
Suprasternal height	22.2496
Shoulder height	22.0926
Stature	21.8813
Bideltoid width	21.5175
Elbow height	21.4748
Span	21.4281
Height of ant.sup.iliac spine	20.6923
Shoulder width	20.1165
Chest circumference	19.9715
Thigh circumference	19.8683
Sitting height	19.7903
Forearm circumference	19.5522
Wrist height	19.2644
Calf circumference	19.1666
Chest breadth	18.7687
Knee height	18.5226
Bitrochanter width	18.4439
Ankle circumference	18.3034
Trochanter circumference	18.2816
Wrist circumference	18.0075
Finger height	17.8887
Back width	17.5181
Upper arm circumference	16.7693
Chest depth	12.9188
Bispinal width	12.7941
Abdomen circumference	10.7868
Ankle height	7.0131

Table 2

Factor 2: PROCERITAS/PROCERITY

Upper arm circumference	26.8375
Abdomen circumference	23.3264
Chest width	20.4626
Trochanter circumference	20.4229
Chest circumference	19.8078
Thigh circumference	19.1900
Forearm circumference	18.5745
Bideltoid width	17.4129
Wrist circumference	15.6068
Bitrochanter width	14.5267
Weight	14.2871
Chest dept	12.3228
Calf circumference	12.2878
Back width	11.5857
Ankle circumference	9.2762
Bispinal width	3.3713
Shoulder width	1.3158
Finger height	-24.8366
Elbow height	-24.3419
Stature	-24.3408
Shoulder height	-24.2077
Knee height	-23.9216
Wrist height	-23.3364
Suprasternal height	-23.2540
Height of ant.sup.iliac spine	-22.8001
Sitting height	-18.0544
Span	-16.2242
Ankle height	-11.8988

Table 3

Factor 3: FIRMITAS/FIRMITY

Abdomen circumference	45.0192
Bitrochanter width	38.7212
Bispinal width	37.8379
Trochanter circumference	35.4136
Finger height	9.3227
Weight	7.2788
Wrist height	5.4543
Elbow height	4.7780
Height of ant.sup.iliac spine	4.6818
Thigh circumference	3.4159
Suprasternal height	3.0730
Chest breadth	3.0276
Shoulder height	2.2471
Stature	2.0302
Back width	-35.2671
Forearm circumference	-25.1195
Wrist circumference	-23.4268
Shoulder width	-19.1353
Calf circumference	-15.4287
Upper arm circumference	-14.2187
Bideltoid width	-10.3473
Chest circumference	-7.8666
Knee height	-5.8736
Span	-5.8720
Ankle circumference	-5.5491
Ankle height	-5.1435
Chest depth	-2.7793
Sitting height	-1.3593

Table 4

Factor 4: INGENIUM MULIERIUM/FEMINEITY

Ankle height	59.4561
Chest depth	38.1968
Bispinal width	29.7543
Shoulder width	19.6510
Knee height	17.2375
Span	16.8999
Chest breadth	12.2753
Bideltoid width	12.1587
Chest circumference	11.8022
Height of ant.sup.iliac spine	2.4722
Trochanter circumference	1.7678
Bitrochanter width	0.2202
Wrist circumference	0.0130
Wrist height	-25.9407
Finger height	-21.5890
Thigh circumference	-18.1788
Ankle circumference	-17.8289
Upper arm circumference	-15.1510
Sitting height	-12.1470
Calf circumference	-11.6169
Abdomen circumference	-11.2941
Elbow height	-10.7072
Forearm circumference	-9.1232
Back width	-6.6931
Weight	-4.8601
Shoulder height	-2.1094
Stature	-2.1053
Suprasternal height	-1.5909

These formulae can be taken into consideration as general characteristics of size: MAGNITUDO/MAGNITUDE, more or less in the sense of "size and shape". The several body measurements are evaluated by such an importance, in which order of succession and with which value they can be seen here /24.1375 x body weight.../.

In the second formula the measures of length are taking part with a negative, while the measures of circumference and width with a positive sign /Table 2/. This formula can be regarded as the characteristic of slenderness: PROCERITAS/PROCERITY; /+ 26.8375 x upper arm circumference ... -24.8366 x finger hight/./We consequently do not use the expressions: linearity and/or gracility, because they already have another meaning in human biology, however procerity - as used above - has essentially the same meaning. We intentionally give Latin terms to our formulae./

By the help of our third formula we can compare the body measurements which constitute the stage of development of the muscles FIRMITAS/FIRMITY /Table 3/.

The fourth of our formulae is constructed on the basis of comparison of the body measurements demonstrated earlier /Table 4/. The explanation of it is not so simple. Provisionally it seems possible to be connected to sexual dimorphism. It is widely known that the female physique either in its constitution or proportions stands nearer the childish shape, than the male one. The fourth formula may include these characteristics. For the time being - conditionally, and in this present sample too - we call it: INGENIUM MULIERIUM/FEMINEITY.

We have to underline the fact, that our four factors are orthogonal to each other, and because of this, each of them independently discloses something about the physique /their correlation related to each other: r = 0/, and they are independent from each other.

Figuring out these characteristics, we merely computed the body measurements of the individuals examined, and they were not fed in according to the branches of sports in case of several individuals. We were eager to know, how these independent characteristics are forming according to the several kinds of sports? The results gained can be interpreted quite well, and give opportunity to the demonstration of a skilful masking procedure.

By the help of the masking procedure, let us examine simultaneously the four factors. Such a tool was constructed by which, applying our four factors, we could study, whether there exist proper reference types of the several branches of sports, which reference types are suitable to pursue a single sport event only, and if there are such, what the respective physique looks like?

Figure 1 depicts our simple apparatus. Above, proceeding downward the possible values of the first, second, third and fourth factor are figured both in negative and positive directions. Below, the respective letter symbols of the examined subgroups with pertaining horizontal fields are given. Letter symbols: S = sprinters, H = Hurdlers, M = Middle-distance runners, L = Long jumpers, I = High jumpers, O = Shot putters, D = Discus throwers, J = Javelin throwers, P = Pentathlonists, F = Fencers, B = Basket ball players, V = Volley ball players, T = Table tennis players, W = Swimmers, U = Students.

The ranges of the examined subgroups are shown by masks prepared for each factor given in the horizontal fields according to the depicted values within the above coordinate system. The values of factor 1 referring to the examined subgroups are shown in Fig. 2; the same of factor 2 in Fig. 3; those of factor 3 in Fig. 4 and the values of factor 4 in Fig. 5.

As an example Fig. 6 illustrates the Sprinters: value of factor 1 is -4.0, small; the values of factors 2 and 3 are practically 0, medium; the value of factor 4 is +1.5, boyish physique. All the other subgroups, excepting the students serving as control, are covered by the masks.

Table 5 summarizes the characteristics of the examined subgroups in the four factors.

Finally, let us examine our masking procedure, that besides the theoretical considerations, what kind of practical applications it may offer.

The computation of the four factors by manual methods is not simple, but in contrast to this, they can be programmed in as computer terminals on several interactive languages. If a group, for example the PhE majors, is programmed, than everybody emerging later, shall be unanimously determined on the basis of their constitutional characteristics, and shall be cleared, in which branches of sports they will produce considerable results, or in which they will not /Fig. 6/. /This method helps the coaches to a secondary choice, or rather in the specialization of the sports events. Obviously, the coach has to decide, whether, that would be the complementary sport of his competitor which is "lighting up", or that one, which is "going out"./

Table 5

Characteristics of the examined subgroups in the four factors

Female subgroups	Factor 1 Magnitude	Factor 2 Procerity	Factor 3 Firmity	Factor 4 Femineity
Sprinters	-4.0 Small	0 Medium	0 Medium	+1.5 Boyish
Hurdlers	+3.0 Corpusculent	+0.5 Medium	0 Medium	+2.5 Manish
Middle distance runners	0 Medium	0 Medium	0.7 Medium	+2.0 Manish
Long jumpers	0 Medium	+1.5 Not slender	+1.5 Strong	+1.8 Boyish
High Jumpers	0 Medium	0 Medium	+2.3 Very strong	+1.7 Boyish
Shot putters	+3.0 Corpusculent	+4.3 Heavy	-0.5 Medium	+0.9 Boyish
Discus throwers	+4.5 Great	+3.2 Thik	0 Medium	+1.5 Boyish
Javelin throwers	+5.0 Great	+0.5 Medium	-2.3 Thin muscles	+1.0 Boyish
Pentathlonists	+6.5 Very great	-3.0 Slender	0 Medium	+1.5 Boyish
Fencers	-5.0 Very small	-3.7 Very slender	+1.6 Rel. strong	-0.8 Girlish
Basket ball players	+3.0 Corpusculent	-4.0 Very slander	+2.0 Strong	-1.0 Girlish
Volley ball players	+6.0 Very great	+1.5 Not slender	+1.7 Rel. strong	-1.8 Womanish
Table tennis players	-6.5 Very small	-3.0 Very slender	-1.5 Thin muscles	-0.4 Girlish
Students	-5.0 Very small	+1.5 Not slender	-2.0 Thin muscles	-1.0 Girlish

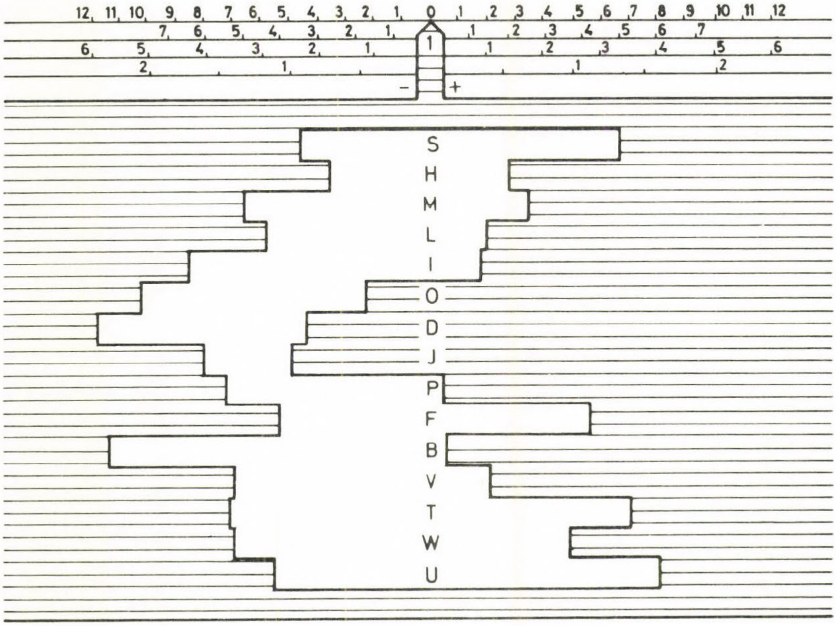

Fig. 1

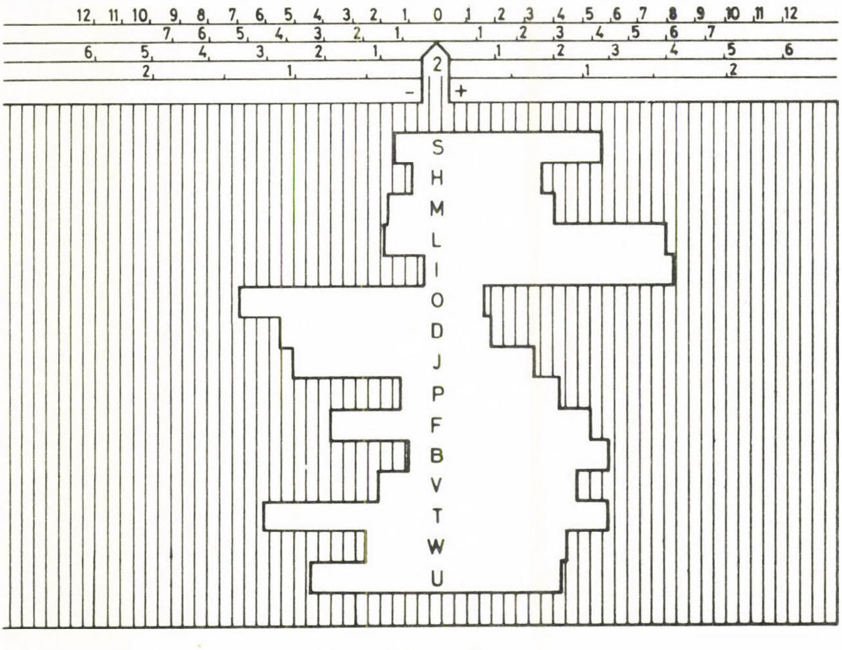

Fig. 2

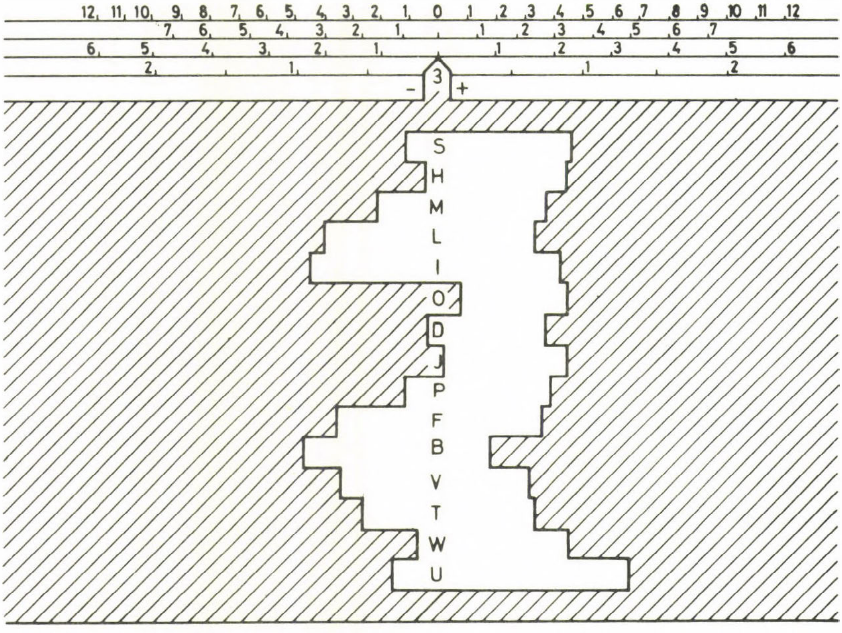
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Fig. 3

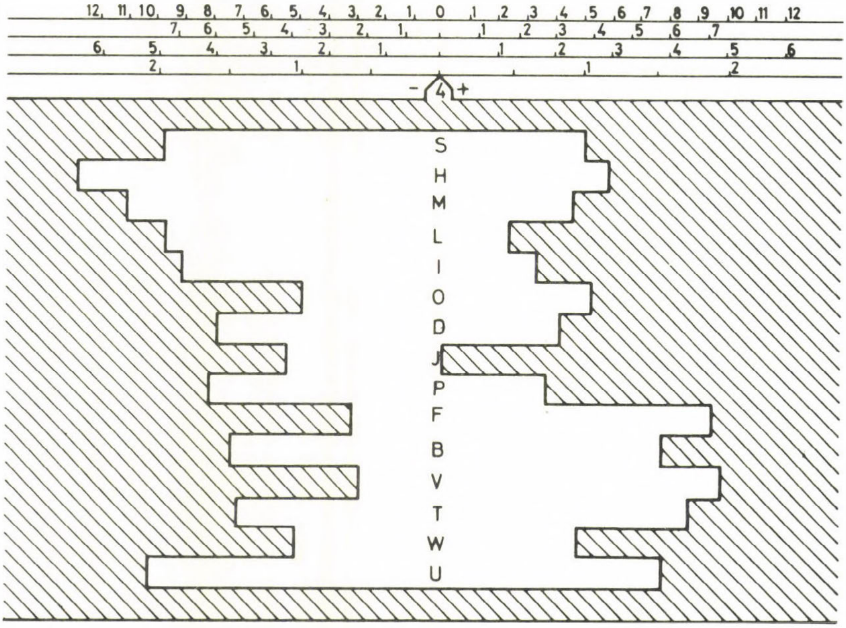
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Fig. 4

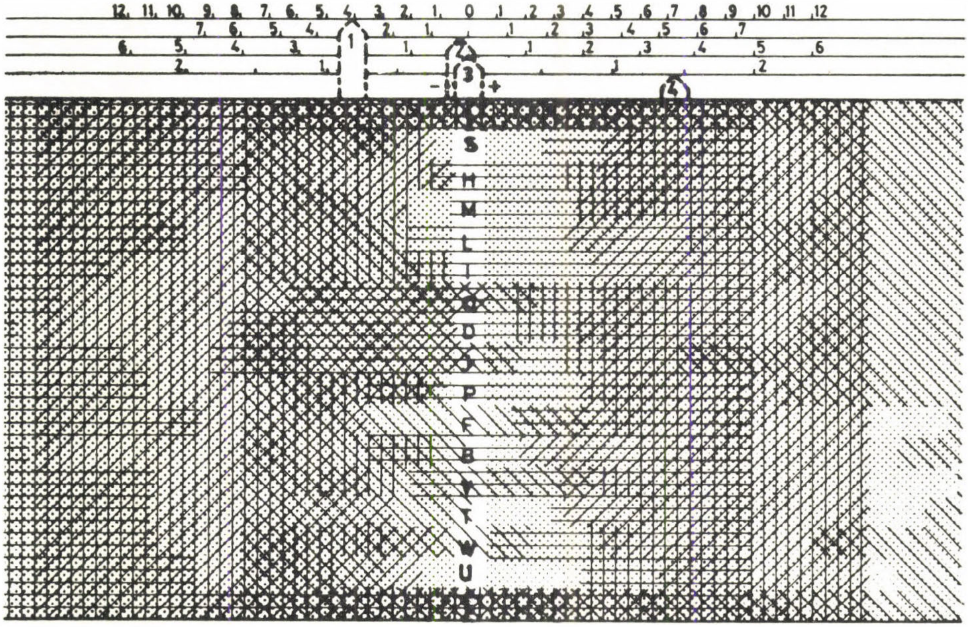
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Fig. 5

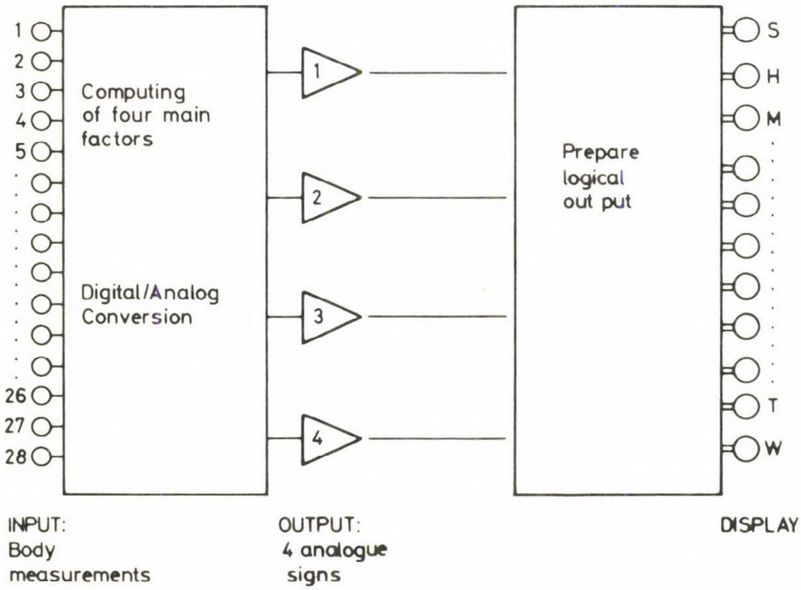
Computing
of four main
factors
Digital/Analog
Conversion
1
2
3
4
Prepare
logical
out put
1
2
3
4
5
26
27
28
S
H
M
T
W
INPUT:
Body
measurements
OUTPUT:
4 analogue
signs
DISPLAY

Fig. 6

Our present investigations are moving in two directions: 1. We are increasing the number of the individuals examined either on the field of different kind of sports, professions, ballet-artists, or of different diseases too /e.g.: Turner's syndrome, testicular feminisation, schizophrenia, and so on/. 2. We want to increase the accuracy of our determinations applying non-linear methods.

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Growth and Development; Physique *Symp. Biol. Hung. 20, (1977)*

FACTORS OF BODY BUILD

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ABSTRACT

Twenty body measurements of students of the Warsaw Technical University, 166 males and 122 females with average age of 21.1 and 20.8 years, respectively, were subjected to a factor analysis, in sex groups, for 4, 5 and 6 factors successively, using the Jöreskog method. Slightly different results were obtained for the two sexes. Four basic factors were always found in the male group: I - the adiposity factor, which loaded all the skinfold measurements; II - the factor of massiveness considering all girths and trunk breadths; III - the length factor, which loaded all the lengths of limb segments and trunk height; IV - the factor loading breadth of distal epiphysis of long bones. The setting apart of the fifth factor did not contribute any new information to the analysis of the male. In the analysis of females the following factors could be set apart: I the trunk adiposity factor, loading trunk skinfolds; II - the factor of massiveness, as in the group of males, but loading also the breath of distal epiphysis of limb bones; III - the factor of length similar to the group of males; IV - the limb adiposity factor, loading the skinfolds of the limbs. In the five and six factor analysis of females the factor loading breadth of distal epiphysis of long bones could be set apart from factor II. It seems, that the analyses, conducted in both sex groups confirm the finding that the female body build is better and more accurately characterized by adiposity factors, while the same of the male is characterized rather by massiveness.

INTRODUCTION

Factor analysis is a method that is frequently used to define body build on the basis of anthropometric measurements. Since the time when Burt and Cohen /cf. Rees 1950/, introduced this method into the field of anthropology, many authors, mainly from English-speaking countries, used it, drawing on a great variety of measurements characterizing body build /Thurston 1947; Howells 1951, 1952; Hammond 1953, 1957; Lorr and Fields 1954; Schreider 1963; Tanner 1964; Knussmann 1968; Vanderberg 1968; Skibińska and Szczotka 1970 and others/. The factors obtained by these authors have not been unequivocally defined owing to, above all, the great variety of the material /age, population, sex, etc./ and the different sets of characters, taken into account by the various authors.

Tanner's /1964/ very thorough analysis and that of Skibińska and Szczotka /1970/, considering the relatively all-round aspect of the sets of body measurements, were conducted with student of physical education, who as a rule are selected subjects, marked by greater height and stronger mesomorphy compared to the population of average youth.

This work is an attempt to provide an answer to the question, what kind of factors we obtain, when analyzing subjects that have not been specially selected, as to their fitness for physical education and sport, and which therefore are relatively representative for the average population of young people; also in what respect the factors obtained will differ from those obtained during the previous work /Skibińska and Szczotka 1970/.

MATERIAL AND METHODS

The material of this work is provided by the anthropometric measurements of 166 male students, their mean age being 21.1 years, and 122 female students aged 20.8 years from the Warsaw Technical University. These young people were not selected as far as somatic body build is concerned, still it is a known fact that these university students constitute a group, which differ slightly from other Polish students because of their slightly greater average height and weight /Pilicz 1963/.

The anthropometric characteristic of the above-mentioned material, i.e. the arithmetic means and the standard deviations, is presented in the work of Milicerowa et al. /1976/.

The analysis encompassed 20 measurements of body build, taken according to the I.B.P. method /Weiner and Lourie 1969/. Skinfolds were measured with the Harpenden caliper. The factor analysis was conducted according to Jöreskog's method /1963/.

RESULTS AND DISCUSSION

The analysis was performed, taking into account successively 4, 5 and 6 factors of each sex.

The results of these analyses are not the same for males and females and sex dimorphism of body build is reflected in these differences.

Table 1 presents the results of the four-factor analysis:

Factor I may be defined as the adiposity factor, but while in the group of males all the skinfolds are in a determined manner loaded with it, in the case of females this factor loads only the trunk skinfolds.

Factor II may be considered to be a factor of general massiveness, a factor of mesomorphy. In male subjects it loads the trunk skeletal frames width and all the girth measurements as musculoskeletal development, but not the widths of distal epiphysis of limb bones which constitute a separate factor. In the female subjects factor II loads in the same manner as is the case with males the trunk skeletal frames /with the exception of biacromial breadth/ girths and additionally width of distal epiphysis of limb bones and trunk height.

Factor III in both sexes defines the length of limb segments and in addition in the male group it loads weakly the trunk length, while in the female group the biacromial breadth.

Factor IV in males loads the breadths of distal long bones epiphysis, and in females it is a factor of limb fat.

Analyses of 5 and 6 factors were not taken into account, because they do not introduce any new information as regards males, only in females this is true of the 5-factor analysis, which out of factor II creates a new one as factor IV, loading the distal width of long bones epiphysis and trunk height, while the limb fat factor has in this analysis been shifted to the fifth place.

In all the analyses, irrespective of the number of factors the first place is, as a rule, occupied by the adiposity factor, which best integrates fat measurements. In males this is the factor of general adiposity, but in females only of trunk fat. As mentioned before, the

Table 1

Four-Factor Analysis of Body Measurements of 166 Men and 122 Women Students

Rotated Factors

		Men factors				Women factors			
		I	II	III	IV	I	II	III	IV
1	Upper arm length	-.091	.127	.808	.131	.069	.117	.851	.037
2	Forearm length	.029	.135	.775	.257	.017	.180	.806	-.023
3	Leg length	-.008	.153	.832	.248	.028	.225	.853	.013
4	Trunk height	-.009	.006	.284	.236	-.000	.551	.121	.039
5	Biacromial diameter	-.034	.452	.405	.201	.305	.348	.403	-.034
6	Transverse chest	.031	.785	.134	.022	.634	.550	.146	-.022
7	Biiliocristal diameter	.175	.462	.441	.284	.497	.366	.238	.291
8	Neck circumference	.161	.612	.107	.249	.447	.501	.039	.100
9	Chest circuference	.228	.789	.141	.066	.706	.511	.099	.087
10	Forearm circumference	.142	.520	.001	.369	.427	.589	-.030	.468
11	Calf circumference	.345	.593	.107	.339	.397	.550	.035	.458
12	Wrist breadth	-.120	.119	.224	.609	-.023	.666	.200	.105
13	Bicondylar humerus	.081	.241	.266	.685	.040	.581	.218	.181
14	Ankle breadth	.019	.158	.250	.569	-.050	.569	.245	.113
15	Bicondylar femur	.343	.284	.212	.617	.275	.558	.014	.526
16	Subscapular skinfold	.848	.121	.030	.017	.773	.054	-.018	.413
17	Axillary line chest skinfold	.894	.108	.023	.009	.740	.124	.018	.428
18	Abdomen skinfold	.859	.064	.047	.096	.794	.112	.046	.295
19	Triceps skinfold	.825	.111	-.050	.105	.199	.156	.042	.544
20	Above knee skinfold	.655	.332	-.167	.096	.272	.159	-.047	.677

limb fat in the group of females constitutes a separate factor. However, in the analysis performed on physical education students /Skibińska and Szczotka 1970/ fat factors occupy further places: in males' analysis the factor of robustness /massiveness/ occupies the first place and in females - it is the length. Probably this is the consequence of training, which does away with the adipose tissue and in that case a more important role is played by such factors as: massiveness in the body build of males and size of body in females /the length factor being factor I/. The inadequate features of factors of adiposity, obtained in two analyses are the outcome above all of the different number of measurements, taken into account. Badora /1975/, conducting a factor analysis of 11 skinfolds measurements of the same university students obtained for males 2 and for females women 3 factors of fat.

Factor II - of general robustness loads measurements, defining in both sexes the general massiveness - mesomorphy, i.e. a more masculine character of body build: larger chest breadth, larger neck girth, but above all larger biacromial breadth. The latter character, though only in the male group, is loaded by factor II. As already mentioned in the previous work /Skibińska and Szczotka 1970/, despite the fact that biacromial breadth is mainly defined by clavicle development, i.e. the long bones, whose measurement is not loaded with the factor of massiveness, in male's build androgenes additionally determine the development of biacromial breadth, by stimulating its greater development in adolescence /Tanner 1962/.

Though in the analysis of female students of physical education measurements of chest breadth and girths are distinctly defined by the factor of massiveness, these measurements are in the case of students of the Technical University, to a high extent also loaded with trunk fat factor as is also the pelvic breadth. In female students of physical education bi-iliac breadth is loaded above all with the length factor, connected with the general body size. Thus, we are bound to accept the fact, that bi-iliac measurement does not unequivocally define the type of body build and cannot be used to determine mesomorphy.

The only girth measurement which in these female students is highly correlated exclusively with factor II is the neck circumference, which has a very high sex discriminating index /Skibińska 1964/. Thus, it is a measurement, which very correctly defines the massiveness of women's budy build, connecting such notions as: massiveness mesomorphy - androgynism.

When setting up random typological systems, such as those based on the method of standard scores, we may precisely take neck girth as a trait characterzing women's mesomorphy, in a relatively "pure" manner.

Factor IV in the analysis of our male students is analogical to factor II of robustness in the case of male physical education students, and is also set apart as the last one. It loads distal epiphysis of limb bones. In females this factor, as mentioned before, appears only in the 5-factor analysis. One may call it, according to Heath /quoting Vanderberg 1968/ "cancellous bone size". It seems that factors II and jointly give expression to mesomorphy of the human physique.

Summing up the results it should be said that certain factors of body build can be found in all the analyses, irrespective of: sex, number of measurements taken into account, and the type of subjects under survey. To such fundamental elements belong:

1. the length factor, which in all the analyses highly loads limb segments, irrespective of the above-mentioned conditions;

2. the element of massiveness - mesomorphy, which may appear in the form of one or two factors; it is much less accurately and in more varied ways defined than other factors, depending to a greater extent on the material analyzed; finally,

3. the element of adiposity, also in the form of one or a larger number of factors as a rule accurately defined.

Among these three elements, obtained through the method of factor analysis, massiveness and adiposity correspond with Sheldon's conception of mesomorphy and endomorphy while our factor of length concentrates rather on the size of the body and not on its leanness, according to Sheldon's ectomorphy.

Supplying an answer to the question asked at the beginning of this work: whether in the light of the factor analysis the body build of young people selected from the point of view of physical fitness, differs from the body build of the average student youth, we might say that the factor analyses, conducted with average youth subjects and selected groups of young people, indicate in the case of athletes the typical influence of selection and physical training on their physique, this the factor analysis reveals by the appearance of other factors in youth doing physical training: endomorphy is less noticeable and the first place is taken by mesomorphic traits in men and body size in women.

ACKNOWLEDGMENTS

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DIFFERENCES IN BODY BUILD BETWEEN WHITES, BLACKS AND MULATTOES

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Abstract

As a result of an analysis of the material of 499 women and 370 men, belonging to the white and black race as well as Mulattoes, the hypothesis found confirmation of the greater similarity in the body build of Mulattoes /men and women/ to the black than the white race.

Using the Mahalanobis's distance method, analyzing 26 somatic traits and five smaller sets of traits, belonging to the principal set, much smaller distances were found between Mulattoes /men and women/ and the black race than the white race.

The reasons for the above-mentioned phenomenon stem from the domination of traits of Blacks in Mulattoes, in the "cumulation of traits" of the black race in mixed groups, due to the more frequent marriages of Mulattoes /men and women/ and Blacks, than between both coloured groups and the white population and finally from the unifying influence of social and material conditions, which are the same for both groups of the coloured population, worse than the conditions of the Whites /before the abolition of racial discrimination/.

x x
x

The purpose of this work is the verification of the hypothesis about greater similarity of body build of Mulattoes and Blacks, than is the case when compared with Whites.

The material deals with 499 women between 17 and 20 years and 370 men between 18 and 20. This is Cuban youth, belonging to the white and black race as well as Mulattoes, surveyed in 1963.

Processing of data was carried out with the help of Odra computer 1204, according to the "mahan" programme by A. Bartkowiakowa /1975/. This programme gives the Mahalanobis's distance for an arbitrary number of features, the linear discriminant function, and the percentage of the properly classified elements.

The total number of analyzed somatometric traits and quotients amounted to 26:

1. Weight
2. Height
3. Arm span
4. Sitting height
5. Biacromial breadth
6. Chest breadth
7. Biiliocristal breadth
8. Bitrochanteric breadth
9. Leg length
10. Neck circumference
11. Chest circumference
12. Waist circumference
13. Hips circumference
14. Triceps skinfold
15. Subscapular skinfold
16. Abdomen skinfold
17. $\frac{\text{Chest circumference + Waist circumference}}{\text{2 x Hips circumference}}$

18. $\frac{\text{Height}}{\sqrt[3]{\text{weight}}}$

19. $\frac{\text{Biacromial breadth}}{\text{Bitrochanteric breadth}}$

20. $\frac{\text{Height}}{\text{Arm span}}$

21. $\frac{\text{Leg length}}{\text{Sitting height}}$

22. $\frac{\text{Arm span}}{\text{Sitting height}}$

23. $\frac{\text{Chest breadth}}{\text{Biiliocristal}}$

24. $\frac{\text{Subscapular skinfold}}{\text{Abdomen skinfold}}$

25. $\frac{\text{Lean body mass}}{\text{Weight}}$

26. $\frac{\text{Lean body mass}}{\text{Weight of subcutaneous fat}}$

A diagnostic value of the 26 features was analized with the help of discriminant coefficients. Next, Mahalanobis s distances were calculated, introducing successively that feature, which provided the highest increase in discriminatory power of the set. In such a manner were established distances $/D^2/$ in the body build of groups compared on the basis of all the traits, taken into account:

	men	women
Whites - Blacks	6.99	7.55
Whites - Mulattoes	3.01	3.55
Blacks - Mülattoes	1.33	1.22

In the successive stage smaller sets of traits were selected, the variables in the regression set were subjected to verification. F^o test was used for checking, whether the m-variables set have a significantly higher discriminant strength that the m-1 variables. The test is being repeated until all the F^o values turn out to be essential on the declared alpha level. The sets discriminating Blacks and Whites as well as Whites and Mulattoes contain 7 traits in men and 8 in women, but Black men and Mulattoes can be divided with the help of one trait /22/, while black women and Mulatto women can be discriminated using two traits /22 and 24/. A total of 18 traits was included into those sets. A mere two of these traits were found 4 times, two traits three times and the remaining ones appeared in 1-2 pairs of groups out of the six that were studied. Thus, one may speak about specific traits, discriminating certain race groups /see table 1/.

Table 1. Mahalanobis s distances /D^2/ between race groups and percentage of good classification of these groups on the basis of verified sets of traits

Whites - Blacks			Whites - Mulattoes			Blacks - Mulattoes		
No. of features	D^2	%	No. of features	D^2	%	No. of features	D^2	%
M e n								
2,6,11,12 18,22,23	6,02	87,8	3,7,11,15 18,21,25	2,25	76,0	22	0,43	63,9
W o m e n								
1,7,11,13 16,22,24	7,33	89,3	1,7,11,14 15,16,20, 21	3,29	80,8	22,24	0,50	65,2

Note, that these discriminating sets included not only features of high individual discriminating value, but mainly those, whose combination with others made up sets of variables well discriminating the different race groups.
Olekiewicz drew attention to this phenomenon, writing "The rank of the significance of a trait in a set depends on the set".

A trait which on its own possesses no diagnostic value can obtain such value in combination with another trait.

Mahalanobis's distances depend to some extent on the number of traits in a set. That is why in the next stage of the work distances were calculated between groups for a certain definite number of variables, equal for all the groups of both sexes that were the subject of comparison. Four sets of traits was selected.

The first set consisted of 6 traits, which were included in the various sets during the first stage. The second contained only skeleton measurements. The third set contained measurements of various elements of body build as well as two quotients. The last one - is an attempt at dividing groups, using only four of the same traits.

It turned out that of the 4 sets of traits the first was the best one. Distances between the examined groups are the largest for these traits and the percentage of good classification of the race groups is the highest as compared with the remaining three sets of traits.

The set with an equal number of traits for all the groups examined possesses less discriminating properties than specific traits, selected by means of statistical verification /Table 1/. This finds its reflection above all in values D^2.

In the case of discrimination, based on the same traits, the percentage of good classification was equal in groups of white men compared with Mulattoes and black men compared with Mulattoes. In women the introduction of the same set of traits did not bring about such equalization. Special attention should be paid to discrimination in the group of black men and Mulattoes. As already mentioned, as a result of statistical verification only one trait was selected: the relation between arm span and sitting height /22/, dividing these two groups. Discrimination of these groups with the use of 6 traits yielded Higher D^2 value and much higher percentage of good classification /from 63.9% to 76.0%/. This fact arouses doubts as to the correctness of one of these results which will be checked. In the group of black women and Mulatto women discrimination with the use of those same 6 traits yielded results very close to discrimination with the use of 2 statistically verified traits.

Table 2. Mahalanobis's distances /D^2/ betwen race groups and the percentage of good classification of these groups on the basis of declared, equal sets of traits

No. of features	Whites-Blacks		Whites-Mulattoes		Black-Mulat.	
	D^2	%	D^2	%	D^2	%
Men						
1,3,7,11,18,22	5.27	87.8	2.15	76.0	0.74	76.0
2,3,4,5,6,7,8,9	3.96	81.8	1.31	65.8	0.59	65.4
4,6,9,12,15,21,24	2.26	74.4	0.66	64.2	0.42	64.4
7,13,18,22	3.69	79.2	1.00	65.8	0.75	65.8
Women						
1,3,7,11,18,22	5.53	87.3	2.66	79.9	0.56	66.6
2,3,4,5,6,7,8,9	4.15	83.2	2.38	76.6	0.38	66.9
4,6,9,12,15,21,24	3.02	79.5	1.38	73.0	0.62	67.2
7,13,18,22	3.98	83.8	2.27	74.4	0.38	65.9

Note, that the largest distances and the highest percentage of possibilities to discriminate were found between the white and black races, which is an expected and obvious result.

The results obtained confirm the hypothesis about greater similarity between the body build of Mulattoes and Blacks than that of the Whites; it turned out that for all the six sets of traits analyzed Mahalanobis s distances betwen Mulattoes and Blacks are always smaller, and in some groups many times smaller than the distances between Mulattoes and Whites.

The described phenomenon could be caused by the following, probable reasons:

1. The dominance of traits of the black race in Mulattoes, men and women.

2. "Cumulation of traits" of the black race in male and female Mulattoes, the majority of whom are not the first generation of Mulattoes. In pre-revolutionary Cuba the popular division of the population was into Whites and Coloured, to which belonged Blacks as well as Mulattoes. The result of this division were the much more numerous marriages between Mulattoes and representatives of the black race, than each one of these groups and white members of the Cuban population. Due to the long period during which such mixed marriages took place the interpretation of the higher share of traits of the black race than the race white in Mulattoes is undoubtedly a highly probable interpretation of the phenomenon under discussion.

3. Another attempt at presenting an explanation could be the higher frequency of transferring to half-breeds the traits of the black race by mothers than by fathers. During the period of slavery of the Blacks the system of a black mother and white father was the basic model and as such has survived the entire period of racial discrimination. Thus, the fact that Mulattoes resembled more

strongly Blacks was the result of the influence of paragenetic factors, such as the intrauterine conditions of the mother and perhaps also the effect of extrachromosomal inheritance, which finds its expression in the larger size of the cytoplasmatic material contained in the ovum, in comparison with the spermatozoon /Jinks 1970/. The influence of the intrauterine conditions on the size of the infants has been proved, but there nevertheless is a lack of evidence whether the effects of such influence remain in force until the mature age, und what is even more important whether they remain as lasting features in the population? Thus, we see, that this interpretation is of a purely speculative nature.

4. In the search for the reasons of the facts found here, one should not omit the social and material conditions. These conditions, being the same for the Blacks and Mulattoes, are worse than those of the Whites and could exert a unifying influence on the group of coloured people, because the Cuban population, analysed here, grew up before the abolition of racial discrimination. In favour of an environmental interpretation /which does not exclude another one, described above/ are two observations: genetically conditioned higher values of the linear traits of the black race, greater body weight, less fat tissues, in general smaller distances between race groups in men than women. The male sex, as it is known, is more sensitive to living conditions.

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THE BODY COMPOSITION AND BODY FAT PATTERNING OF MALE AND FEMALE ATHLETES

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Athletes, due to selection, and/or physical training differ from the general population in respect to their physique in several ways. This descriptive study of body fat compares athletes to normals and athletes to athletes.

METHODS:

Subjects.

Two groups of athletes were studied. The first group were Canadian athletes competing at the Pan American Games and the second were college athletes from the University of Western Ontario, London, Canada. The 120 male and 121 female college students were physical education students from the same University. The 154 male Pan American athletes represent 14 sports and the 53 female Pan American athletes represent 6 sports. There were 47 college males from 4 sports and 72 college female athletes from 7 sports.

Test Procedures.

Subcutaneous fat fold thicknesses were measured at 7 sites on the Pan American athletes and on 15 sites with the college athletes and college students using the Harpenden Skinfold Caliper.

Table 1

BODY COMPOSITION OF

MALE AND FEMALE ATHLETES

	PAN AM ATHLETES		COLLEGE ATHLETES		COLLEGE STUDENTS	
	Male	Female	Male	Female	Male	Female
% FAT	6.1	14.5	7.0	16.8	9.0	17.5
FAT WEIGHT (KG)	4.7	9.0	5.5	10.3	7.1	10.7
FAT FREE WEIGHT (KG)	69.8	51.8	72.5	50.2	74.1	49.1
WEIGHT (KG)	74.5	60.9	78.0	60.5	81.2	59.8

Table 2

BODY FAT MEASUREMENTS

CANADA'S MALE ATHLETES PAN-AMERICAN GAMES 1967

	SPORT	Tricep	Sub-Scapular	Supra-Iliac	Umbilical	Front Thigh	Chest	Calf	Total	% Fat
4	Diving	4.8	7.3	7.3	7.4	7.7	4.5	8.9	47.7	2.3
10	Swimming	5.8	7.4	7.8	8.1	8.5	5.4	9.4	52.3	5.8
10	Water Polo	6.4	8.6	7.4	7.5	9.1	5.9	8.5	53.3	8.1
16	Track & Field	5.3	8.6	6.0	7.0	7.4	5.7	6.8	46.8	4.2
8	Wrestling	6.0	9.3	6.6	9.1	8.8	6.6	7.6	54.0	4.1
10	Volleyball	5.8	8.1	5.8	7.4	8.8	6.4	7.8	50.1	5.7
18	Soccer	5.8	9.0	7.7	9.1	9.2	6.5	10.0	57.4	5.9
15	Field Hockey	7.4	9.8	7.9	10.7	8.7	8.0	8.2	60.6	8.9
24	Rowing	6.1	8.2	6.0	6.5	8.9	5.0	8.2	49.0	6.7
11	Canoeing	6.7	9.1	6.4	8.2	9.1	7.0	8.2	54.7	7.9
6	Shooting	7.8	13.9	12.3	20.0	13.9	13.5	12.3	93.8	11.8
8	Boxing	6.7	8.0	6.9	8.8	9.4	5.9	10.2	56.0	4.2
7	Gymnastic	4.9	6.6	4.8	5.8	6.8	4.7	6.3	39.9	1.2
6	Basketball	5.6	8.3	6.8	8.7	8.7	5.8	8.0	51.9	4.5
154	Athletes	6.1	8.7	6.9	8.5	8.8	6.3	8.5	53.9	6.1

Body density was determined by hydrostatic weighing. Residual air was determined by helium dilution with the college athletes and students, but was estimated for the Pan American athletes as 22% of the individual's vital capacity. The equation of Brozek and Keys ($\frac{4.57}{\text{B. Density}} - 4.142$) converted body density values to total body percent fat values.

RESULTS:

Body Composition.

The data shows that females have lower body densities and therefore higher percent fat values than their male counterparts. They have greater subcutaneous fat thicknesses than the males except for the supra-iliac, subscapular and mid-axillary sites where they appear to be similar (Tables 1-5).

Fat Patterning.

The distribution of the exterior mantle of subcutaneous fat (body fat patterning) can be seen by plotting the thickness values. When the values for the Pan American athletes are plotted on an absolute scale and compared with the college students it is quite apparent that males differ from females.

The Pan American athlete has less fat than his/her normal counterpart but is similar in patterning. Even when the number of sites are increased from 6 to 15, the graph shows the college males to be similar to the college athlete but dissimilar from the college female athlete and college student (Figs 1 and 2, see also Tables 2-5).

p. 2

Table 3

BODY FAT MEASUREMENTS

CANADA'S FEMALE ATHLETES PAN-AMERICAL GAMES 1967

S P O R T		Tricep	Sub-Scapula	Supra-Iliac	Umbilical	Front Thigh	Rear Thigh	Calf	Total	% Fat
12	Swimming	10.0	8.6	8.7	12.0	15.9	17.6	17.1	89.8	14.1
7	Gymnastics	9.0	6.9	5.5	7.0	12.7	16.3	12.5	69.9	11.1
12	Basketball	12.5	9.9	7.6	13.0	21.8	23.7	18.4	107.0	16.8
11	Volleyball	11.9	8.1	8.1	13.3	18.2	19.3	17.8	96.8	16.9
7	Canoeing	11.8	8.5	7.3	10.8	19.1	24.9	18.9	101.4	12.4
4	Diving	9.6	8.2	8.5	10.4	16.2	25.7	16.8	95.2	11.6
53	Athletes	11.0	8.5	7.7	11.6	17.9	21.0	17.4	95.0	14.5

Table 4

BODY FAT MEASUREMENTS OF

COLLEGE MEN AND MALE ATHLETES

FAT SITES	COLLEGE MEN 120	COLLEGE ATHLETES 47	SWIM	WRESTLING	FOOTBALL
Forearm	5.3	5.5	5.2	4.8	6.1
Bicep	4.3	4.3	4.1	3.9	4.6
Tricep	7.6	8.0	8.3	6.9	8.6
Sub-Scapula	11.9	11.2	10.5	9.7	11.3
Supra-Iliac	11.1	11.2	13.5	10.7	11.1
Umbilical	13.8	12.1	12.1	8.6	12.1
Pubis	6.7	5.7	5.5	4.5	6.5
Mid-Axillary	8.7	9.0	8.0	6.6	9.0
Trochanter	11.2	11.5	13.2	9.9	12.4
Lower Medial Thigh	15.6	12.8	9.3	8.9	15.4
Upper Medial Thigh	11.2	8.2	6.6	5.3	7.6
Front Thigh	12.6	10.5	10.5	9.6	10.4
Rear Thigh	11.2	11.0	9.8	7.6	12.2
Calf	10.4	8.7	8.0	6.9	9.1
Medial Calf	6.8	6.8	6.5	5.9	7.2
Total (15 sites)	144.5	136.2	131.0	109.5	143.5

Table 5

BODY FAT MEASUREMENTS OF
COLLEGE WOMEN AND WOMEN ATHLETES

FAT SITES	COLLEGE WOMEN 121	COLLEGE ATHLETES 72	SWIM	VOLLEY BALL	BASKET BALL	HOCKEY
Forearm	6.8	6.9	8.0	6.3	6.5	7.0
Bicep	6.7	6.7	8.4	7.9	5.4	6.5
Tricep	15.5	13.7	15.3	13.2	11.3	16.2
Sub-Scapula	12.8	11.7	13.3	12.3	9.4	11.7
Supra-Iliac	10.1	11.7	14.0	11.6	9.9	11.9
Umbilical	14.5	14.2	15.5	14.9	12.9	13.9
Pubis	15.7	13.5	16.7	16.9	12.4	11.3
Mid-Axillary	10.3	9.0	10.7	9.7	7.5	9.0
Trochanter	27.2	28.6	35.0	25.0	22.9	30.5
Lower Medial Thigh	25.6	23.7	26.5	23.7	23.2	25.7
Upper Medial Thigh	18.3	14.4	17.4	13.3	10.6	16.5
Front Thigh	24.5	20.7	22.4	20.3	18.4	22.1
Rear Thigh	27.4	24.1	27.6	22.3	21.7	27.1
Calf	19.7	18.5	18.4	18.4	18.4	20.9
Medial Calf	14.6	13.8	14.8	13.8	12.1	15.7
Total (15 sites)	245.6	235.9	263.8	226.8	210.8	245.9

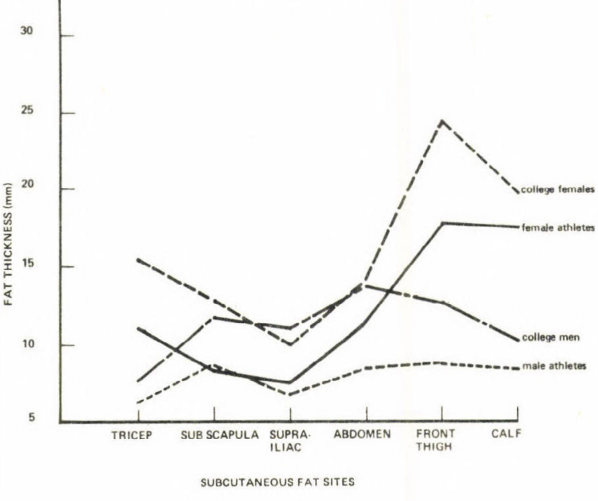

Fig. 1

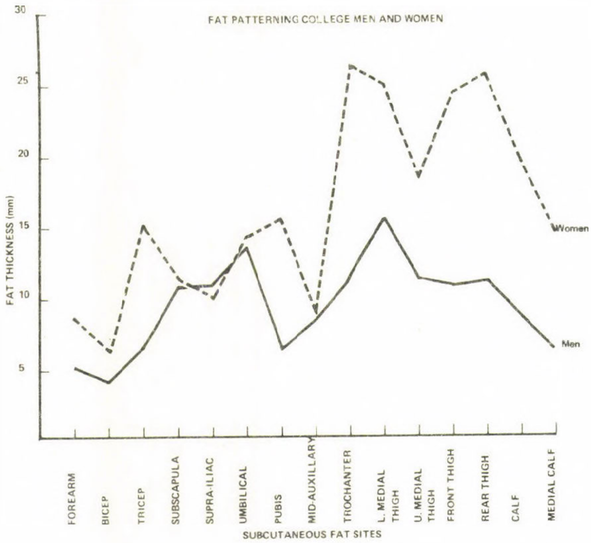
FAT PATTERNING COLLEGE MEN AND WOMEN
FAT THICKNESS (mm)
30
25
20
15
10
5
Women
Men
FOREARM
BICEP
TRICEP
SUBSCAPULA
SUPRA-ILIAC
UMBILICAL
PUBIS
MID-AUXILLARY
TROCHANTER
L. MEDIAL THIGH
U. MEDIAL THIGH
FRONT THIGH
REAR THIGH
CALF
MEDIAL CALF
SUBCUTANEOUS FAT SITES

Fig. 2

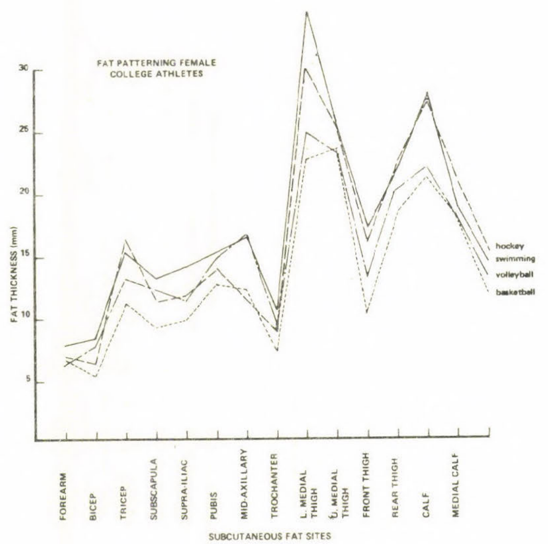
FAT PATTERNING FEMALE COLLEGE ATHLETES
FAT THICKNESS (mm)
30
25
20
15
10
5
hockey
swimming
volleyball
basketball
FOREARM
BICEP
TRICEP
SUBSCAPULA
SUPRA-ILIAC
PUBIS
MID-AXILLARY
TROCHANTER
L. MEDIAL THIGH
U. MEDIAL THIGH
FRONT THIGH
REAR THIGH
CALF
MEDIAL CALF
SUBCUTANEOUS FAT SITES

Fig. 3

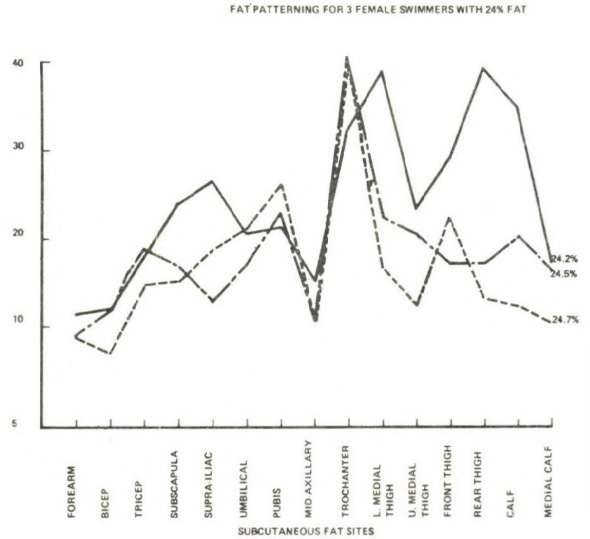
FAT PATTERNING FOR 3 FEMALE SWIMMERS WITH 24% FAT
40
30
20
10
5
24.2%
24.5%
24.7%
FOREARM
BICEP
TRICEP
SUBSCAPULA
SUPRA-ILIAC
UMBILICAL
PUBIS
MID-AXILLARY
TROCHANTER
L. MEDIAL THIGH
U. MEDIAL THIGH
FRONT THIGH
REAR THIGH
CALF
MEDIAL CALF
SUBCUTANEOUS FAT SITES

Fig. 4

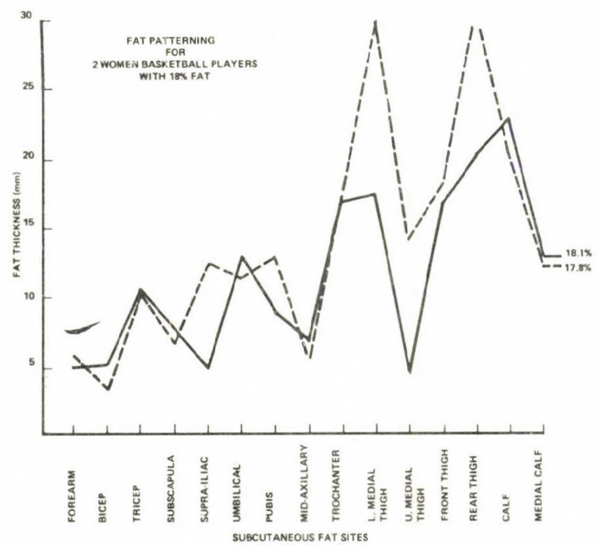
FAT PATTERNING
FOR
2 WOMEN BASKETBALL PLAYERS
WITH 18% FAT
FAT THICKNESS (mm)
30
25
20
15
10
5
18.1%
17.8%
FOREARM
BICEP
TRICEP
SUBSCAPULA
SUPRA-ILIAC
UMBILICAL
PUBIS
MID-AXILLARY
TROCHANTER
L. MEDIAL THIGH
U. MEDIAL THIGH
FRONT THIGH
REAR THIGH
CALF
MEDIAL CALF
SUBCUTANEOUS FAT SITES

Fig. 5

When inter-sport comparisons were made, the graphical representation showed the patterns to be similar. Athletes, when grouped by sport and sex do not differ from each other. However, there may be wide individual variations within sports. Two female swimmers were selected who had almost the same relative body fat value of 24%. The graph shows that athletes participating in the same sport distribute the same amount of fat in dissimilar patterns. The intrasport variability in fat pattern also held for female volleyball and basketball players, and male wrestlers and football players (Figures 3-6).

DISCUSSION:

It is not at all surprising that athletes have lower fat values than normals, and that national athletes have lower fat values than college athletes. Conversely it is also apparent that athletes have a greater fat free mass than non-athletes. The demands of sport are such as to increase the lean body mass, and decrease the fat mass which is a hinderance to performance in most sport events.

A distinct difference is apparent in body fat patterning between males and females when considering mean fat thickness values for athletes engaged in different sports they do not appear to differ from college students nor from each other. However wide fluctuations in body fat patterning are possible within the sex group and suggest an individualized fat patterning, porbably inherited and sex linked. Athletes within a sport do not have the same body fat pattern. Where similarities exist, it is probable due to selection. It is quite unlikely that participation

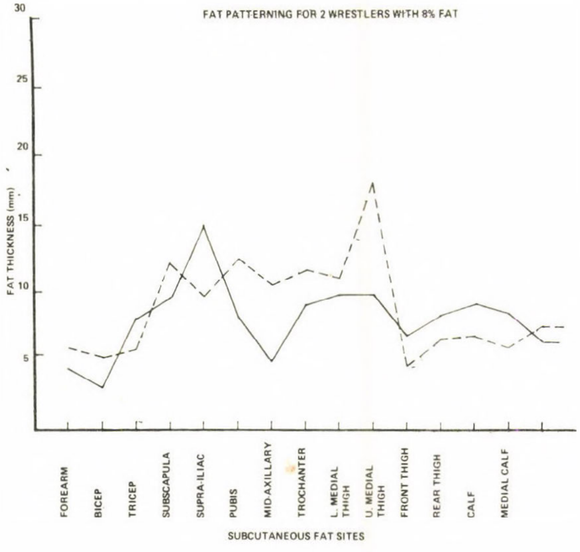

Fig. 6

in a specific sport moulds the subcutaneous fat pattern in similar ways for each competing athlete. It is also postulated that when body fat is lost or gained the fat layer does not respond in different ways to different exercise regimens or sport activities. The fat layer does not change proportionately either with total body fat changes.

It is further suggested that the fat layer does not change proportionately in thickness with changes in total body fat, but probably according to the individual's own pattern. The individual will lose or gain fat in the same way whether he loses his fat by dietary restriction, running, swimming, or involves himself in gymnastic activity.

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A NEW APPROACH TO THE STUDY OF INTERCORRELATIONS AMONG BONE, MUSCLE AND FAT COMPONENTS OF UPPER ARM

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ABSTRACT

Inter-relationships between bone, muscle & fat have been computed from the width measurements as well as cross-sectional areas of the respective tissues using soft tissue radiographs of right upper arm of 47 males. The relationships among bone-muscle and muscle-fat have improved to the level of significance by using the cross-sectional areas instead of tissue widths. Detailed mathematical interpretations have been given to explain why cross-sectional areas are better indicators of the amounts of various tissues of limbs rather than their radial widths. In the light of the new approach, independence of bone, muscle & fat from each other, reported by various authors, need to be re-examined.

INTRODUCTION

Sheldon(1940)advocated that there is a marked association between tissues such as muscles and bones and that these could be expressed as a single component of the physique. Baker et al.(1958) working on the growth pattern of brachial tissues observed compact bone to be significantly correlated with muscles. Cumming et al.(1973) found calf bone width to be significantly correlated with calf muscle width. On the other hand, it has been reported by various authors that bone, muscle & fat in the limbs are independent of each other (Reynolds,1944; Reynolds & Askawa,1950; Clarke et al.1956; Baker et al.1958;Tanner et al.1959; Tanner 1964 & 1965; Johnston & Malina,1966; Malina

& Johnston 1967; Singh,1967). Nevertheless, from the structural & functional aspect, it is probable that bulky muscles be supported by thicker bones. Thus, in this context a need for re-examination of the whole issue was considered necessary. While doing so, it has been found that the cross-sectional areas, rather than tissue widths, are much better indicators of the amounts of limb tissues. Keeping this in view, a new approach has been suggested to establish the relationships among the limb tissues.

MATHEMATICAL INTERPRETATION

In upper arm, the structure of various tissues may be assumed to correspond to three concentric cylinders; bone forming the central cylinder, muscle and fat overlying it-later surrounding the former. Any increase/decrease in bone diameter will also affect changes in the widths of the other tissues. However, these changes in the widths may not necessarily reflect the proportionate changes in the amounts of respective tissues. For instance, increase in bone diameter would mean that musculo-adipose ring now surrounds a larger central axis. Therefore, theoretically speaking, if amount of muscles & adipose fat remains same, their radial widths would decrease. This phenomenon has been explained below mathematically by taking a practical example, considering bone, muscle and fat cross-sections to be circular in shape.

Fig. 1. represents diagramatically the cross-sections of upper arms of two subjects X_1 and X_2.

Let, r_1 & r_2 be the radii of upper arms; r_1' & r_2' radii of lean tissues; and r_1'' & r_2'' the radii of skeletal tissues of the subjects X_1 and X_2 respectively.

Thus (r_1-r_1') and $(r_1'-r_1'')$ are the radial widths of skin plus subcutaneous fat, and muscle tissues reppectively of subject X_1. The corresponding values for subject X_2 are (r_2-r_2') and $(r_2'-r_2'')$.

Let, $r_1-r_2=\delta r$ --------------(1.1)

$r_1'-r_2'=\delta r'$ --------------(1.2)

$r_1''-r_2''=\delta r''$ --------------(1.3)

KEY WORDS

Tissue widths, cross-sectional areas, correlation coefficients.

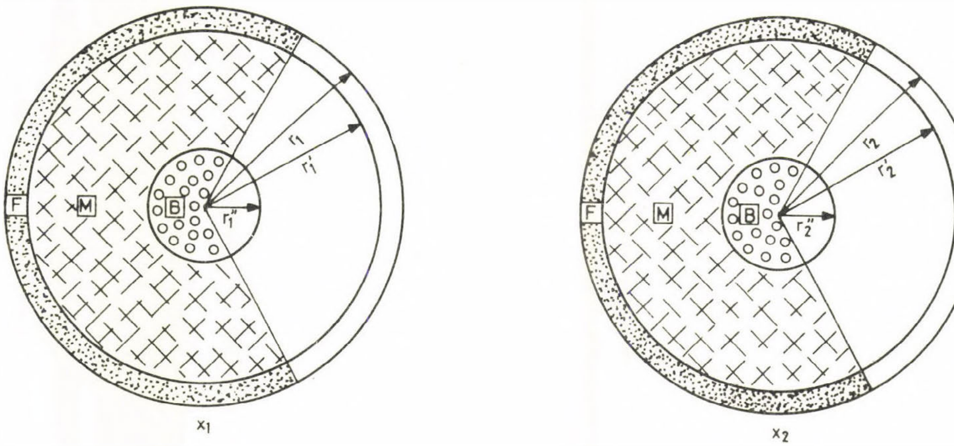

Fig.1: Diagrammatic illustration of the cross-sections of upper arms of two subjects X_1 and X_2. F represents skin plus subcutaneous fat,M-muscles and B-bone.

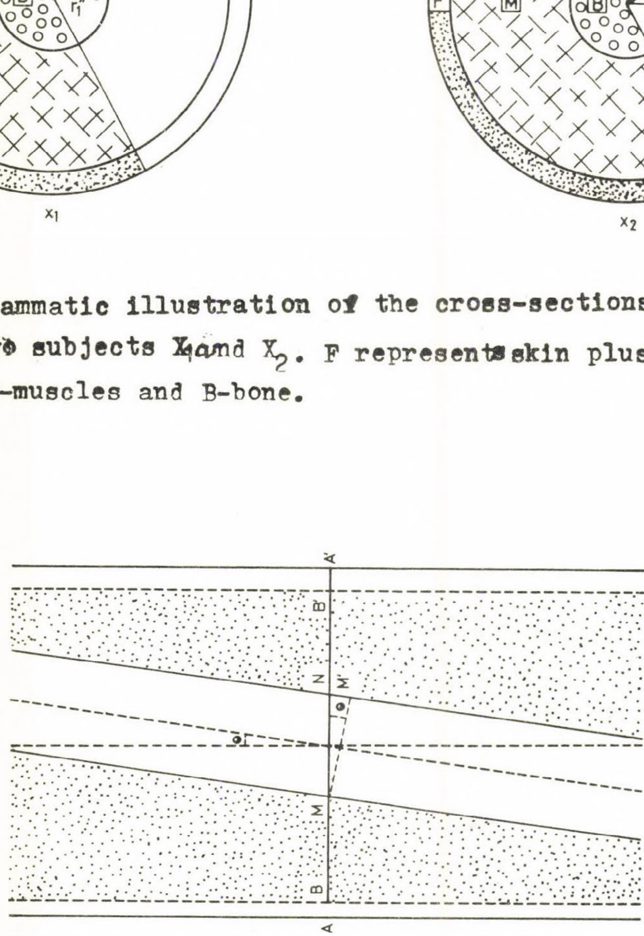

Fig.2. Diagrammatic illustration of radiographic measurements of upper arm.AA' represents total diameter; BB' -lean tissue diameter; MM'&MN-bone diameters.

Suppose, B_1a & B_2a reppesent the areas of bone; M_1a & M_2a = areas of muscle; and F_1a and F_2a = Areas of skinplus subcutaneous fat, of subjects X_1 and X_2 respectively.

Further, Let, $B_1a-B_2a=\delta Ba$; $M_1a-M_2a=\delta Ma$; & $F_1a-F_2a=\delta Fa$

Firstly, taking only bone and muscle into consideration:

$$B_1a=\pi(r_1'')^2,\quad B_2a=\pi(r_2'')^2 \quad \text{and}$$

$$M_1a=\pi\left\{(r_1')^2-(r_1'')^2\right\},\quad M_2a=\pi\left\{(r_2')^2-(r_2'')^2\right\}$$

or

$$\delta Ba=\pi\left\{(r_1'')^2-(r_2'')^2\right\} \text{ - - - - - - - - - - - - -}(2.1)$$

$$\delta Ma=\pi\left\{(r_1')^2-(r_1'')^2\right\}-\pi\left\{(r_2')^2-(r_2'')^2\right\} \text{ - - -}(2.2)$$

Putting the value of r_1'' from eq.(1.3) in eq.(2.1), we get: $\delta Ba=\pi\left\{(\delta r'')^2+2r_2''\,\delta r''\right\}$ - - - - - - - - - - - -(3)

Similarly, putting the values of r_1' and r_1'', from eqs.(1.2) & (1.3) in eq.(2.2) above:

$$\delta Ma=\pi\left\{2r_2'\delta r'+(\delta r')^2-2r_2''\delta r''-(\delta r'')^2\right\} \text{ - -}(4)$$

For example:

Let, $\delta r''=0.5$mm, $r_2'=40.0$mm & $r_2''=10.0$mm.
Putting these values in eq.(3) above:

$$\delta Ba=32.21\text{mm}^2 \text{ - - - - - - - - - - - - - - - - - -}(5)$$

Since, humerus of subject X_1 is considered to be thicker than that of subject X_2, muscle width of X_1 may have the following three theoretical possibilities:

Possibility-I:

X_1 may have slightly greater muscle width than that of X_2 i.e. $\delta r' > \delta r''$.

Suppose $\delta r'=1.5\,\delta r''$

Now, replacing $\delta r'$, $\delta r''$, r_2' & r_2'' by their respective values, mentioned above, in eq.(4), we obtain:

$$\delta Ma=158.12\text{mm}^2 \text{ - - - - - - - - - - - - - - - - -}(6)$$

Thus, slightly greater muscle width of a subject having thicker bone results in a substantial increase in his muscle area.

Possibility-II:

X_1 may have the same muscle width as that of X_2 i.e.

i.e.$\delta r' = \delta r''$

Again replacing $\delta r'$, $\delta r''$, r_2' & r_2'' by their respective values in eq.(4):

$$\delta Ma = 94.28mm^2 \text{ - - - - - - - - - - - - - - - - - } (7)$$

Thus, it is evident that with the same muscle width, the muscle area of the subject having thicker bone is greater to an extent of $94.29mm^2$ when his bone width is bigger only by 0.5mm.

Possibility-III:

X_1 may have slightly lesser muscle width than that of X_2. i.e. $\delta r' < \delta r$

Now, suppose $\delta r' = 0.75\delta r''$

Again, putting the values for $\delta r'$, $\delta r''$, r_2' & r_2'' in eq.(4), we get:

$$\delta Ma = 62.51mm^2 \text{ - - - - - - - - - - - - - - - - - } (8)$$

Thus, it is possible , that a subject having smaller radial muscle width may have bigger cross-sectional area (amount) of the tissue as compared to another subject with larger muscle width.

It is, evident from tab.1 that cross-sectional areas of bone & muscle are better indicators of the amounts of respective tissues rather than their radial widths. Hence, computation of 'r' from width measurements may not necessarily provide a correct picture of the relationship between bone and muscle.

A similar trend is evident while dealing with the study of relationship of subcutaneous fat with bone/muscles in the limbs.

MATERIAL AND METHOD

Soft tissue radiographs of right upper arm of 47 males belonging to Jat-Sikh community, ranging in age from 21 to 23 years, form the material of the present study. The teahniques employed have been described elsewhere (Sidhu et al., 1975).

Fig.2. gives the diagrammatic illustration of bone, muscle and subcutaneous fat widths as measured on the radiographs. The cross-sectional areas of bone, lean tissue, muscle and subcutaneous fat have been computed as described below:

(i) Cross-sectional Area of Bone (Ba):

Since, humerus does not lie parallel to the longitudinal axis of the upper arm but at an angle, say θ. Hence, cross-section of the bone, perpendicular to the arm axis, would represent an ellipse with MM' and MN as the smaller and greater diameters respectively (Fig.2.). The cross-sectional area of this, ellipse,represents the area of the bone in the middle. Thus, $Ba = (\frac{\pi}{4} MN.MM')$.

The bone is surrounded by muscle and fat rings. Assuming these rings to be circular in shape cross-sectional area of Lean tissue, (La) is $\frac{\pi}{4}(BB')^2$.

(ii) Cross-sectional Area of Muscle (Ma):

$Ma = La - Ba$.

(iii) Cross-sectional Area of Subcutaneous Fat (Fa):

It is obtained by subtracting lean tissue area from upper arm area (Ua) i.e. $Fa = Ua - La$, where $Ua = \frac{\pi}{4}(AA')^2$.

Correlation coefficients between bone-muscle, bone-fat and muscle-fat were computed from these cross-sectional areas as well as directly from their radiographic widths.

RESULTS AND DISCUSSION

The values of inter-correlations between bone, muscle and fat components of the limbs, as reported by various investigators are enlisted in Tab.2. Most of these values indicate independence of all the three components from each other. However, judging from structural and functional aspects of these tissues, it has been generally felt that there should be some association, atleast between bones and muscles (Sheldon, 1940; Tanner, 1964; Johnston & Malina, 1966). We applied Mathematical equations to prove that cross-sectional area rather than radial width, is a much better indicator in representing the amount of a tissue in the limbs. Intercorrelations between bone, muscle and subcutaneous fat were computed from their widths as well as cross-sectional areas so as to examine, if there is any improvement in the relationship with the later (Tab.3.). As expected, the values of correlation coefficients have improved between muscle and bone from 0.282 to 0.385; between muscle and fat from 0.284 to 0.530; and between bone and fat from 0.157 to 0.196.

It is interesting to note that the values of 'r' when obtained from tissue widths indicated independence of all tissue components from each other- the same trend as has been hitherto reported (Reynolds, 1944; Reynolds & Askawa, 1950; Clarke et al. 1956; Tanner et al. 1959; Tanner 1964 & 1965; Johnston & Malina, 1966; Malina & Johnston, 1967; Singh, 1967). However, when we applied the new approach for calculating these values from cross-sectional areas, it was found that there existed a statistically significant relationship between bone & muscle and between muscle & fat. This positive association between the tissue components, could not be ascertained earlier due to improver expression of the amounts of various tissues in the form of widths. Nevertheless, the value of 'r' between bone & fat remained statistically insignificant even by applying the new approach indicating thereby that these components of the upper arm may be independent of each other.

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Tab.1. Values of radial widths & cross-sectional areas of bone and muscle as obtained from three theoretical possibilities taking two subjects X_1 & X_2 where X_1 has a thicker bone.

	Width (mm)			Cross-sectional areas (mm^2)		
	X_1	X_2	X_1-X_2	X_1	X_2	X_1-X_2
Bone	21.00	20.00	1.00	346.55	314.3	32.21
Muscle: Possibility-I (X_1 with larger muscle width)	60.50	60.00	0.50	4872.62	4714.50	158.12
Muscle: Possibility-II (Both having equal muscle width)	60.00	60.00	0.00	4808.79	4714.50	94.29
Muscle: Possibility-III (X_1 with lesser muscle width)	59.75	60.00	-0.25	4777.01	4714.50	62.51

Tab.2. Inter-correlations between tissues of upper arm, thigh and calf as reported by various authors.

		Reynolds, 1944	Reynolds & Askawa, 1950	Clarke at al., 1956	Baker et al., 1958	Tanner et al., 1959	Tanner, 1964 & 1965	Johnston & Malina, 1966	Malina & Johnston, 1967	Singh, 1967	Cumming et al., 1973
Bone & Muscle	M	-.17	.077	-	(.36*)	.03	.09	.256	.095	.219	.30*
	F	-	.053	-	-	.13	-	.226	.040	-	.28*
Bone & Fat	M	.30	-.033	-	(.03)	.02	-.07	.154	.280	.062	-
	F	-	.008	-	-	.07	-	.229	.235	-	-
Muscle & Fat	M	-.02	.224	-	.26	.16	.08	.145	.120	.196	-
	F	-	.160	-	-	.09	-	.202	.180	-	-
Fat & Lean tissue	M	-	-	.11	-	-	-	-	-	.195	-
	F	-	-	-	-	-	-	-	-	-	-
Region		Calf	Calf	Upper arm	Upper arm	Average of Upper arm, Thigh & Calf		Upper arm	Calf	Upper arm	Calf
Age Status		Children	Adults	Univ. Students.	Adults	Young-men & Young-women	Students	6 to 16 yrs.	6 to 16 yrs.	Adults	13 to 16 yrs.
Number	M	49	100	30	31	44	125	182	176	52	103
	F	-	100	-	-	166	-	181	180	-	168

*Significant at 5% level. M= Males, F= Females.

Values in parenthesis indicate computation of 'r' using compact bone measurements.

Tab.3. Inter-correlations between bone, muscle and fat of upper arm computed from cross-sectional areas (upper right) and from width measurements (lower left).

Widths		Cross-sectional areas	
	Bone	Muscle	Fat
Bone	-	0.385*	0.~~200~~ 196
Muscle	0.282	-	0.530*
Fat	0.157	0.285	-

*Significant at 5% level.

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SOMATOMETRIC AND PERSONALITY-TYPOLOGIC INVESTIGATIONS IN TWO GROUPS OF SCHIZOPHRENICS

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Abstract

Somatometric data was collected and a study of personality typology made for 28 cyclophrenics and 28 hebephrenics. The results showed the possibility of classification on the basis of the metric characters and the personality typology data, which could be compared to the clinical condition.

Introduction

Even clinical observation in the course of dealing with the patients strikingly showed the significant differences of a physical nature between the different groups of patients. The constitutional work of Kretschmer (1955) from the psychiatric approach appeared to offer a good starting point. However, according to our observations there are significant constitutional differences not only between patients suffering from manic-depressive psychosis and schizophrenia, but also within the schizophrenia spectrum. We attempted to confirm these observations by including a somatometric study in the five-year follow-up study of endogenic psychotic patients conducted in the Department of Psychiatry in the Semmelweis University of Medicine, Budapest (Pethő et al., 1975).

Material and method

Use of the Leonhard (1957) method for diagnosis and follow-up, which has prognostic value, made it possible to distinguish the presumed disease entities within the heterogeneous spectrum of schizophrenia. As a first step we studied the nosologically two most extreme disease entities within the schizophrenia spectrum: hebephrenia and cyclophrenia. The two groups each consisted of 28 female patients and were well matched for scholastic qualifications, social situation and marital status. The age distribution of the two groups differs significantly due to the different age of onset: $\bar{x}_{cy}=41.32$, while $\bar{x}_{he}=30.86$ years; $p < 0.05$. Since both values are located near the centre of the adult age group we did not consider them to be a source of error from the somatometric point of view.

Psychiatric classification was made on the basis of two studies, or three studies in the majority of cases (for 25 cyclophrenics and 19 hebephrenics). The somatometric study was made when patients were in a compensated condition. When quantified on the basis of the Rockland-Pollin rating scale (1965) the two groups produced characteristically different results and the two samples can thus be considered as quite separate. We measured a total of 32 metric characters: body weight, stature, sitting height, symphysis height, shoulder height, finger height, height of ant. sup. iliac spine, shoulder width, waist width, bispinal width, bitrochanter width, chest breadth, chest depth, wrist breadth, femur condyle breadth, ankle breadth, head-ear height, maximum head length, maximum head breadth, morphological face height, bizygomatic breadth, mandibular angle breadth, horizontal head contour, chest circumference, waist circumference, abdomen circumference, trochanter circumference, upper arm circumference, forearm circumference, wrist circumference, calf circumference, ankle circumference. Using an R 20 computer in the Computer Group of the Semmelweis Medical University, a cluster analysis was made of this data to determine whether a classification could be made purely on the basis of the metric data, without taking diagnostic considerations into account. In the first step we formed two groups and then several.

The sample taken from the two clinical disease entities falls into two groups on the basis of metric characters; one is formed of 11 patients and the other of 44. The smaller group is composed of 10 cyclophrenics and 1 hebephrenic. The other group is made up of 17 cyclophrenics and 27 hebephrenics. One cyclo-

Table 1

t test to establish the significance of deviation in the different body measurements for the two groups of patients

(degree of freedom = 54)

(* = value very close to the 5% confidence level)

Parameter	t	significance
body weight	2.73484	$p < 0.01$
stature *	1.80535	-
sitting height	3.50890	$p < 0.001$
symphysis height	1.63549	-
shoulder height	1.44405	-
finger height	1.42197	-
height of ant.sup. iliac spine	1.60609	-
shoulder width	0.46313	-
bitrochanter width	4.44654	$p < 0.001$
waist width	2.90181	$p < 0.01$
bispinal width	3.41284	$p < 0.001$
chest breadth *	1.79922	-
chest depth	1.40270	-
wrist breadth	5.92087	$p < 0.001$
femur condyle breadth	5.44058	$p < 0.001$
ankle breadth	7.76194	$p < 0.001$
head-ear height	0.22515	-
maximum head length	3.04450	$p < 0.001$
maximum head breadth	1.39037	-
morphological face height	1.04369	-
bizygomatic breadth	1.74466	-
mandibular angle breadth	2.36672	$p < 0.02$
horizontal head contour	3.00576	$p < 0.01$
chest circumference	1.70305	-
waist circumference *	1.86565	-
abdomen circumference	3.51396	$p < 0.001$
trochanter circumference	3.03280	$p < 0.01$
upper arm circumference	2.02028	$p < 0.05$
forearm circumference *	1.84814	-
wrist circumference	1.63447	-
calf circumference	5.37376	$p < 0.001$
ankle circumference	5.20390	$p < 0.001$

phrenic patient was an outlier with respect to both groups. Application of the F test, based on mean square deviation from the cluster centres, excluded the possibility of the null hypothesis (according to which the entire sample of 56 patients actually forms a single schizophrenia group). The points representing the individuals studied are distributed in the 32-dimensional space in such a way that the average between group distance (9.1975) considerably exceeds the average inside group distance (6.31569). In view of the heterogeneous nature of the group composed of a higher number of elements, we attempted a breakdown into more groups. By omitting outliers, the sample could be broken down into six groups. Each group presented essentially the same picture: a smaller cyclophrenic group, a largely cyclophrenic group and one or two largely hebephrenic groups emerged.

Using the t test to select 16 characters which differ significantly ($p < 0.05$) for the cyclophrenic and hebephrenic group (see Table 1) we carried out the group-forming operation using only these characters. When two groups were formed on the basis of the 16 characters there was an increase in the size of the cyclophrenic group and the density of the elements within the groups increased (4.46552). Here too, further breakdown to four groups produced results which could be evaluated.

The next stage was to select ten of the significantly differing variables, making sure that these 10 variables gave important, independent information. These were: body weight, sitting height, waist width, maximum head length, mandibular angle breadth, ankle breadth, horizontal head contour, trochanter circumference, upper arm circumference, ankle circumference. Breakdown could be made to six groups, but in this case too, evaluation was only possible up to four groups (see Table 2).

Thus, on the basis of the metric data and postulating the existence of four groups we attempted to compare the results of the cluster analysis:

1) with other factors having no diagnostic influence:
   a) to determine whether the effect of age on the constitution is reflected in the formation of the sub-groups;

Table 2 Cluster analysis groupings which can be evaluated

	cyclophrenic group	mainly cyclo-phrenic group (Cy + H)	hebephrenic group (Cy + H)	inside group distance	between group distance
On the basis of 32 body measurements					
1 group (no breakdown)				7.58105	
2 groups	Ø	10 + 1	18 + 26	6.31569	9.1975
5 groups	6	14 + 8	1 + 8 2 + 9	5.45687	7.5716
On the basis of 16 body measurements					
1 group				5.35955	
2 groups	Ø	16 + 3	12 + 25	4.46552	6.4256
3 groups	9	15 + 13	1 + 14	3.89688	6.4256
4 groups	8	14 + 3	1 + 12 2 + 12	3.58199	5.4151
On the basis of 10 body measurements					
1 group				4.21767	
2 groups	11	Ø	17 + 28	3.58335	5.5588
3 groups	10	15 + 8	2 + 19	3.05363	4.5163
4 groups	9	7 + 1	1 + 12 8 + 14	2.82424	4.2817
5 groups	8	13 + 3	Ø + 11 1 + 8	2.68423	4.0796

b) whether the effect of the number of births in modifying the constitution is reflected in the same way.

2) We also attempted to establish a relation between the sub-groups and more precise diagnostic sub-groups than those already used, involving 3 sub-groups within the group of cyclophrenics, 4 sub-groups within the hebephrenics and also mixed forms of the latter. (See Leonhard, 1957)

3) Finally, we used our own 13-item personality typological rating scale to compare the personality picture formed on the basis of the estimated value of the individual personality factors with the somatometric results.

The four sub-groups were formed on the basis of the 16 characters which proved to be significant and were composed as follows: 1) cyclophrenics (Cy_1), 2) mainly cyclophrenics (Cy_2), 3) first group of hebephrenics (H_1) and 4) second group of hebephrenics (H_2).

Results

On the basis of the values obtained (see Table 3) it is obvious that the difference between cyclophrenics and hebephrenics is decisive in the overall personality picture too and this cannot be linked to the age and number of births which also differ significantly for the two groups.

The only significant difference between Cy_1 and Cy_2 is in age and it can therefore be supposed that the somatometric deviation between the two groups is due solely to age. In addition to this, there is a slight deviation in the number of births and in the "Cyclothymia" value among the personality factors (close to the 5% confidence level). While the difference in size between the H_1 and H_2 groups could be attributed to the difference in the number of births, since this is not large in the absolute sense (numerically) and there is significant deviation ($p < 0.05$) in 2 personality typology factors (Cyclothymia and Typus anancasticus), deviation in the psychophysical basis (the "endon") cannot be excluded.

In conclusion it can be said that the validity of Leonhard's nosological division of the schizophrenic spectrum is also reflected in the somatometric data: the metric characters of

Table 3

Comparison of the two groups of patients and their sub-groups with the non-metric data. Results of the t test

	Cy - H	Cy_1 - Cy_2	H_1 - H_2
1/a Age	4.22112	-2.82274 (23)	-0.34722 (23)
1/b Number of births	3.87298	-1.99904* (23)	-2.34415 (23)
2) Internal diagnosis	18,86436	-1.00441 (23)	0.22962 (23)
3) Personality typology:			
Walton-Presly	-4.92343	-0.96077 (6)	0.25459 (14)
Alanen-Wender	-8.18232	-0.99662 (6)	1.20317 (14)
Schizoidia	-12.17702	1.09577 (21)	-1.56581 (21)
Cyclothymia	7.15772	1.99682* (21)	2.29646 (21)
Type melanch.	2.20209	0.55692 (21)	-0.46399 (21)
Type ekthetic	12,24276	-1.55252 (21)	-0.29455 (21)
Type akatastic	-1.19364	0.91191 (21)	-1.44927 (21)
Type anoigetic	-3.00185	-1.32509 (21)	-1.70548 (21)
Type heboid	-22.70132	0.40069 (21)	0.27660 (21)
Type katatonic	-5.16500	0.68252 (21)	-0.54533 (21)
Type paranoid	-2.18789	0.81716 (21)	-1.55748 (21)
Type hysteroid	0.53068	-1.44196 (18)	2.44747 (20)
Type anancastic	2.51962	-0.19570 (18)	0.20000 (20)

(The first column is Cy - H; degree of freedom = 54. In the second and third columns, the figure in brackets indicates the degree of freedom.

For the underlined values $p < 0.05$.

Values marked * are close to the 5% confidence level.)

cyclophrenics and hebephrenics point to the existence of differing characteristics for the two disease entities. This is also supported by the results of our personality typology studies.

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THE PHYSIQUE OF PATIENTS SUFFERING FROM TURNER'S SYNDROME

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ABSTRACT

Forty-five parameters of body measurements of patients with Turner's syndrome and testicular feminisation respectively were examined according to Martin and according to the standards of the International Biological Programme. Clinical and cytogenetical investigations were carried out previously. 164 healthy, fertile women served as controls. All individuals examined were Europids, Hungarians.

The total af the characteristics of the body measurements was standardized and reduced to its orthogonal factors, to the so-called normal components. The patients were represented in a plane system of coordinates on the basis of the vectors of body measurements. All the three groups /Turner's syndrome, testicular feminisation, and the control group/ had a characteristic place in this system.

Using this method the anthropological characteristics of the patients with Turner's syndrome and of testicular feminisation were pointed out, and the known phenotypic stigmata of these syndromes were revaluated.

INTRODUCTION

Under Turner's syndrome we understand a disturbance in the sexual development of females being concomitant with low stature, sexual infatilism, little or no pubic or axillary hairs, rudimentary and/or dysgenetic ovaries /connective matrix not containing primordial follicles and other ovarian tissue elements; streak gonad/ high gonadotropin secretion with the urine, chromatin negativity, monosomia of the X-chromosome and several facultative somatic characteristics /deviations of the skeletal, cardiac and vascular system, of the urogenital apparatus/.

The classical triad described by Turner in 1938: infantilism, pterygium colli /webbed neck/, twisted elbow, has consequently widened to a polysymptomatic clinical picture.

By the term Turner's group such clinical forms are summed up which are partly somatic, partly sexual developmental anomalies, and show - probably through the cytogenetic picture - phenomena related to Turner' syndrome. Concerning cytogenetics the partly normal and partly pathologic lines of sexual chromosomes associated with caryotype 45,X are characteristic for them. Pelying on such characteristics the hypogonadal clinical pictures concomitant with the caryotypes X/XX or X/XY ranked among the Turner's group, and patients displaying low growth and structur deviations of the second chromosome /45,X/46,XXp-, 45,X/46,XXq-, 46,XXpi, 46,XXqi, 46,XXr/ also belong here. Lately the translocation of the X-chromosome has been described, partly for autosomes and partly for homologous chromosomes.

MATERIAL AND METHOD

Physique biological examination has been carried out on 34 patients suffering from various chromosome anomalies and on 164 healthy, fertile women. The present study selects 16 cases and discusses in detail which on the basis of genetical and clinical diagnosis have been ranked among either to Turner's syndrome or to Turner's group. The mean age of the 16 patients was $\bar{x}$ = 21.25 years /W = 15.18–32.25 years/. The mean age of the healthy, fertile women was $\bar{x}$ = 27.00 years /W = 16.92–44.42 years/. The latter group comprised of women without selection who appeared at that time in our Institute. The lowest age limit was set to be 17 years with a view to the fact that Hungarian women reach their adult body height nowadays at the age of 16-17 years /Eiben et al. 1971/. All of them belong to the Europid race and are Hungarians.

According to the instructions of Martin - Saller /1957-1966/ and of the International Biological Programme /Tanner - Hiernaux - Jarman 1969/ we performed a detailed anthropometrical programme covering a total of 45 body measurement. The examinations have been carried out always in the forenoon, between 9 and 12 o'clock. The present study elaborates those 30 body measurements which are considered to be the most important ones as far as physique biological characterization is concerned /Eiben 1972/. The processing of the data was made by the help of a Razdan II electronic computer. The usual parameters are given. The physique biological elaboration was done by factor analysis broken down to normal components.

RESULTS AND DISCUSSION

The mean values of body measurements and other parameters of the two groups are given in Table 1. The mean values of the fertile women correspond to the same of an "average population" of Hungarian women. Comparing these mean values with those of two groups of Hungarian high-school girls /Eiben 1965, 1972/ we may give with high certainty the standard values of Hungarian women, as it has already been done and the results plotted in a somatogramme /Sándor - Eiben - László 1974/.

The body height of patients suffering from Truner's syndrome varies between 127.2 and 152.4 cm, yielding a mean of $\bar{x}$ = 142.36 cm. The proportion of extremity length and body height practically is the same as for fertile women: rel. length of upper extremity $\bar{x}$ = 43.11 /of fertile women $\bar{x}$ = 43.62/, rel. bispinal width $\bar{x}$ = 56.22 /of fertile women $\bar{x}$ = 56.06/. The proportionality of extremities does not deviate from the same of fertile women. The length of individual extremity segments compared to circumference the proportion is stocky, referring to relative muscularity. The proportions of stature and span $\bar{x}$ = 101.28%, in other words, the span is longer /in 75% of the cases/ than stature. This again well corresponds with the same in fertile women x = 100.22.

The broad, stocky trunk of Turner's syndrome patients is well characterized by the rel. biacromial width $\bar{x}$ = 24.50 /in fertile women $\bar{x}$ = 23.04/ and the rel. bitrochanter width $\bar{x}$ = 21.52 /in fertile women $\bar{x}$ = 20.73/. The value of trunk width index obtained from these two measurements $\bar{x}$ = 87.84 well indicate both absolutely and relatively the broad shoulders /in fertile women the value of the same index is $\bar{x}$ = 90.00/. The rel. chest circumference is likewise great $\bar{x}$ = 58.82 /in fertile women $\bar{x}$ = 52.64/.

By calculating the combination of body measurements we hoped to make a detailed analysis of the divation of stature characteristics of patients suffering from Turner's syndrome from a normal population. Since we assume that those small groups within a certain population whose individuals suffer from some kind of illness or are in the state of pathology /in our case it is a chromosome anomaly /do in fact differ in stature from the normal population.

The sum of the characteristics of the body measurements of the examined persons was standardized and broken down to orthogonal factors, so-called normal components /Eiben 1969, 1972/. As far as the examined problem was concerned a few such normal components proved to be sufficient.

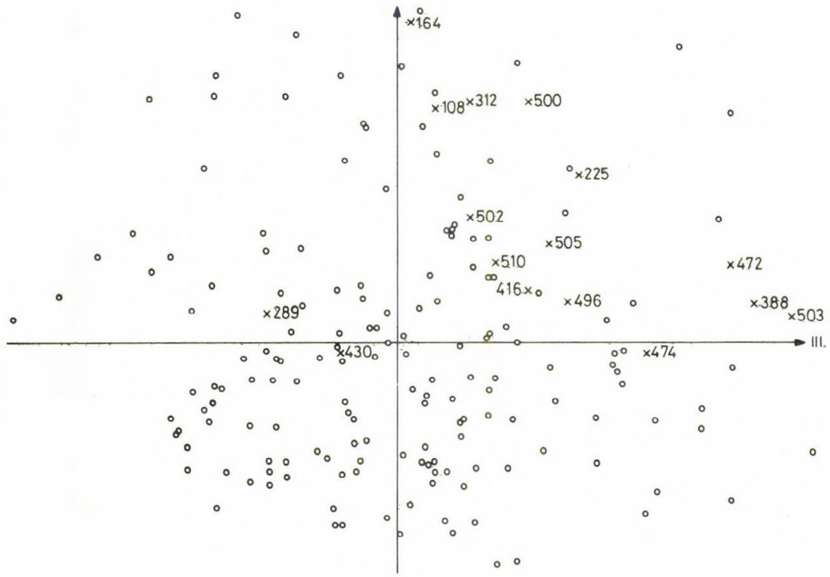
The Ist normal component reflects the general data of the examined persons, its coefficient referring to the examined persons can be the general measure of "size and shape".

The IInd normal component indicates the deviation from the average body measurements, its coefficient the morphological form and robustivity of the body, while

the IIIrd normal component shows the secondary differentiating measurements and its coefficient the muscularity.

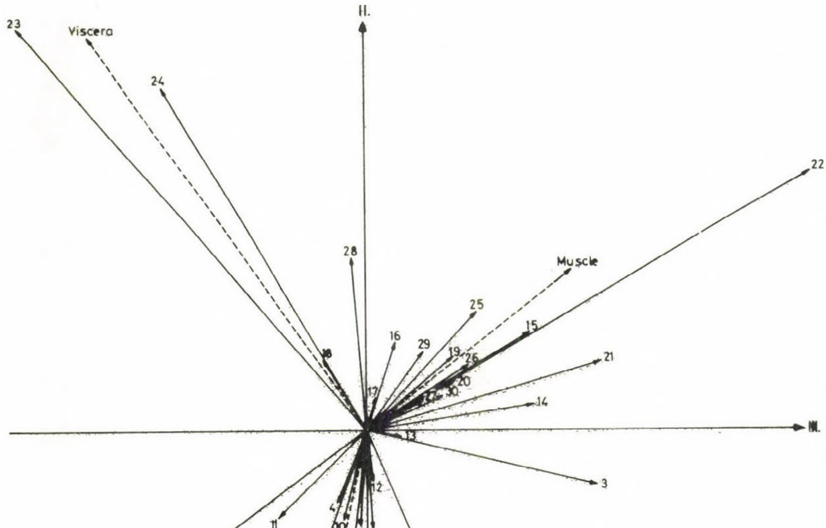
We know from earlier examinations /Eiben 1972/ that it is most convenient to plot the data of the examined persons in the plane coordinate system of the IInd and IIIrd normal components. While the fertile women populate all four fields of this coordinate system, the Turner's syndrome patients are situated along a very characteristic hyperbolic curve /Fig. 1/.

It is the body measurement vectors which determine the grounds of body features represented in the coordinate system. Pogure 2 shows body measurement vectors of which those of length measurements /the individual body measurements on the basis of their serial numbers may well be correlated with those in Table 1/ point downwards, thus, in the negative direction of the IInd normal component a linear main trend may be observed. In the upper right-hand field referring to the positive branch of the IInd and IIIrd normal compoents those body measurement vectors are seen which determine primarily the dimensions of the upper part of trunk, i.e. the robusticity of the body. Because of the broad, muscular shoulders this direction can be considered as the muscle direction. According to the positive IInd normal component and the negative branch of the IIIrd normal component, i.e. in the upperleft-hand field, those body measurement vectors accumulate which determine the lower part of the trunk /bitrochanter width, trochanter circumference, abdomen circumference/, this is the visceral direction.



II.
×164
×108
×312
×500
×225
×502
×505
×510
×472
416×
×496
×388
×503
×289
III.
×430
×474

Fig. 1.



II.
23
Viscera
24
22
28
Muscle
25
15
16
29
19
26
21
20
14
13
III.
3
12
4
11
10
8
9
5
6
7
2
Linearity

Fig. 2.

Table 1 Comparative data on patients with Turner' s syndrome and Fertile female controls

Body Measurements	Patients with Turner' s syndrome (n = 16)				Fertile women (n = 164)			
	$\bar{x}$	$s_{\bar{x}}$	s	Range	$\bar{x}$	$s_{\bar{x}}$	s	Range
1. Body Weight	48. 45	1. 82	7. 28	31. 8 − 58. 4	58. 14	0. 77	9. 87	41. 6 − 93. 5
2. Stature	142. 36	1. 62	6. 48	127. 2 − 152. 4	159. 35	0. 44	5. 66	145. 5 − 174. 5
3. Sitting Height	76. 88	0. 87	3. 49	71. 4 − 81. 8	84. 97	0. 23	3. 00	76. 8 − 98. 6
4. Arm Span	144. 18	1. 83	7. 34	125. 2 − 159. 5	159. 00	0. 53	6. 80	135. 5 − 178. 3
5. Suprasternal Height	115. 89	1. 37	5. 49	105. 8 − 124. 6	130. 43	0. 40	5. 15	117. 7 − 150. 4
6. Symphysion Height	74. 35	1. 47	5. 88	64. 8 − 90. 1	83. 05	0. 35	4. 42	72. 1 − 98. 3
7. Acromial Height	115. 70	1. 49	5. 95	102. 3 − 124. 0	130. 35	0. 46	5. 88	116. 5 − 163. 4
8. Radial Height	91. 10	1. 24	4. 95	80. 6 − 98. 0	102. 46	0. 34	4. 29	90. 4 − 113. 1
9. Stylion Height	71. 51	0. 95	3. 81	65. 1 − 77. 0	80. 96	0. 35	4. 45	71. 7 − 97. 7
10. Dactylion Height	53. 60	0. 88	3. 50	47. 2 − 58. 8	61. 51	0. 29	3. 76	53. 2 − 85. 5
11. Iliospinal Height	80. 04	1. 16	4. 65	70. 1 − 88. 4	89. 33	0. 34	4. 41	79. 6 − 103. 3
12. Tibial Medial Height	38. 08	0. 83	3. 30	33. 4 − 48. 4	42. 72	0. 20	2. 53	28. 7 − 49. 2
13. Sphyrion Tibial Height	6. 59	0. 25	1. 00	4. 9 − 8. 6	7. 47	0. 08	1. 00	4. 7 − 10. 4
14. Biacromial Breadth	34. 88	0. 48	1. 91	30. 5 − 38. 0	36. 71	0. 12	1. 60	33. 2 − 41. 8
15. Bideltoid Breadth	39. 30	0. 56	2. 23	34. 5 − 42. 6	40. 60	0. 21	2. 73	35. 5 − 49. 7
16. Waist width	23. 61	0. 35	1. 40	21. 4 − 26. 3	24. 42	0. 18	2. 36	20. 0 − 35. 1
17. Bispinal Breadth	22. 91	0. 42	1. 70	19. 0 − 26. 9	24. 61	0. 14	1. 79	19. 6 − 32. 7
18. Bitrochanteric Breadth	30. 64	0. 52	2. 07	26. 0 − 34. 0	33. 04	0. 19	2. 38	27. 7 − 42. 0
19. Transverse Mesosternal Breadth	25. 13	0. 35	1. 39	22. 8 − 27. 9	26. 41	0. 16	2. 01	23. 0 − 34. 5
20. A−P Chest Depth	16. 83	0. 39	1. 55	13. 1 − 19. 7	16. 78	0. 12	1. 48	13. 0 − 21. 0
21. Back Width	31. 55	0. 41	1. 64	27. 9 − 34. 0	31. 65	0. 17	2. 16	26. 9 − 38. 9
22. Chest Girth (Mesosternal)	83. 73	1. 27	5. 08	71. 4 − 91. 0	83. 88	0. 48	6. 17	73. 1 − 101. 7
23. Abdominal Girth (Umbilicus)	81. 89	1. 75	7. 01	69. 1 − 96. 7	82. 63	0. 71	9. 10	67. 1 − 108. 1
24. Trochanteric Girth (Hip)	85. 96	1. 67	6. 69	73. 2 − 99. 2	91. 01	0. 63	8. 05	74. 1 − 119. 2
25. Arm Girth (Extended)	25. 10	0. 81	3. 22	20. 1 − 34. 6	25. 29	0. 23	2. 89	20. 0 − 35. 1
26. Forearm Girth	22. 10	0. 30	1. 18	18. 7 − 23. 7	22. 68	0. 14	1. 74	19. 7 − 27. 4
27. Wrist Girth (distal to styloids)	14. 66	0. 14	0. 54	13. 2 − 15. 7	14. 95	0. 08	0. 97	13. 1 − 19. 5
28. Thigh Girth	50. 63	1. 09	4. 36	44. 0 − 59. 2	54. 50	0. 39	4. 95	44. 4 − 71. 8
29. Calf Girth (standing)	31. 98	0. 62	2. 48	26. 5 − 35. 6	33. 71	0. 24	3. 06	20. 1 − 46. 5
30. Ankle Girth	21. 97	0. 43	1. 70	19. 0 − 24. 5	21. 49	0. 12	1. 53	18. 2 − 26. 9

Thus the examined patients hyperbolistic distribution in the coordinate system becomes obvious: they fall far off from linearity. This hyperbola is determined by their robusticity /biacromial width, chest circumference, etc./ and muscularity /circumference of extremities, primarily of thigh circumference/.

Eiben and Heath /in preparation/ jointly classified the somatotypes of the Turner-patients. The average somatotype of them is 5.5–4.1–0.8. The somatotypes in the three components vary as follows: endomorphy 3.0–7.5, mesomorphy 3.0–5.0 and ectomorphy 0.5–1.5.

Finally, the thirty sets of data for each group was adjusted for height and expressed as phantom z-scores /ROss - Wilson 1974/. The z-scores for each set of data in each group was compared and proportionality differences between the two groups were examined.

The z-scores showed that patients suffering from Turner's syndrome were proportionally larger in girth measurements and proportionally smaller in height measurements than the fertile female controls /Fig. 3/.

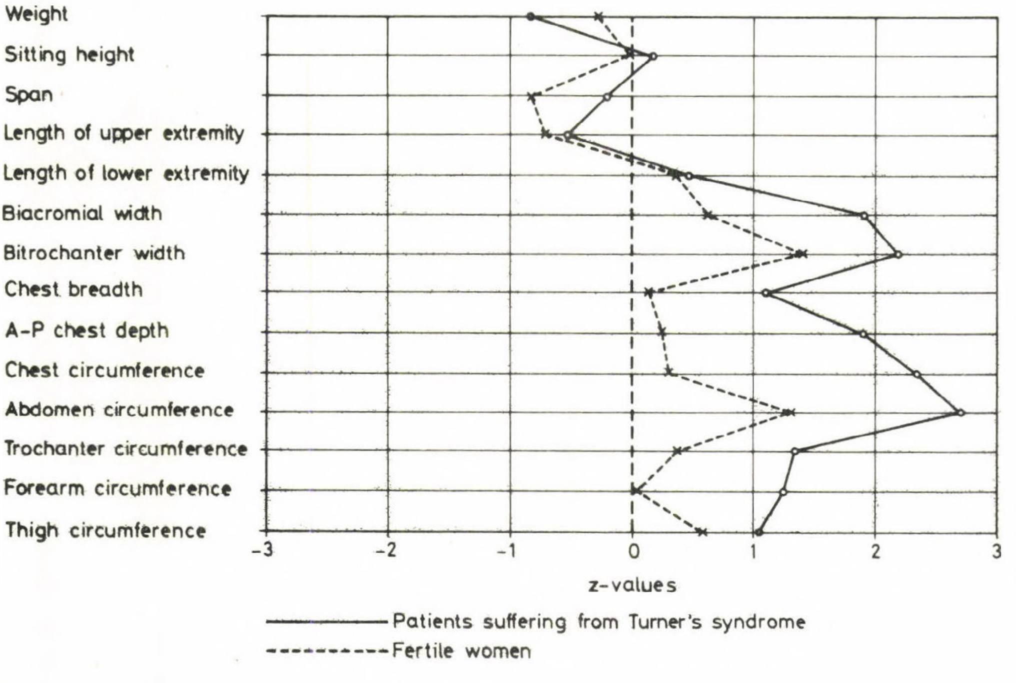


Fig. 3.

The stature and, in proportion with it, all length measurement of the patients suffering from Turner's syndrome are smaller than those of the normal female population. As compared with this, their measurements of width are relatively larger, especially that of shoulder width. Similarly, also the measurements of circumference of the trunk and extremities are larger /Table 1/. All this results in a low stature and a stocky build.

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